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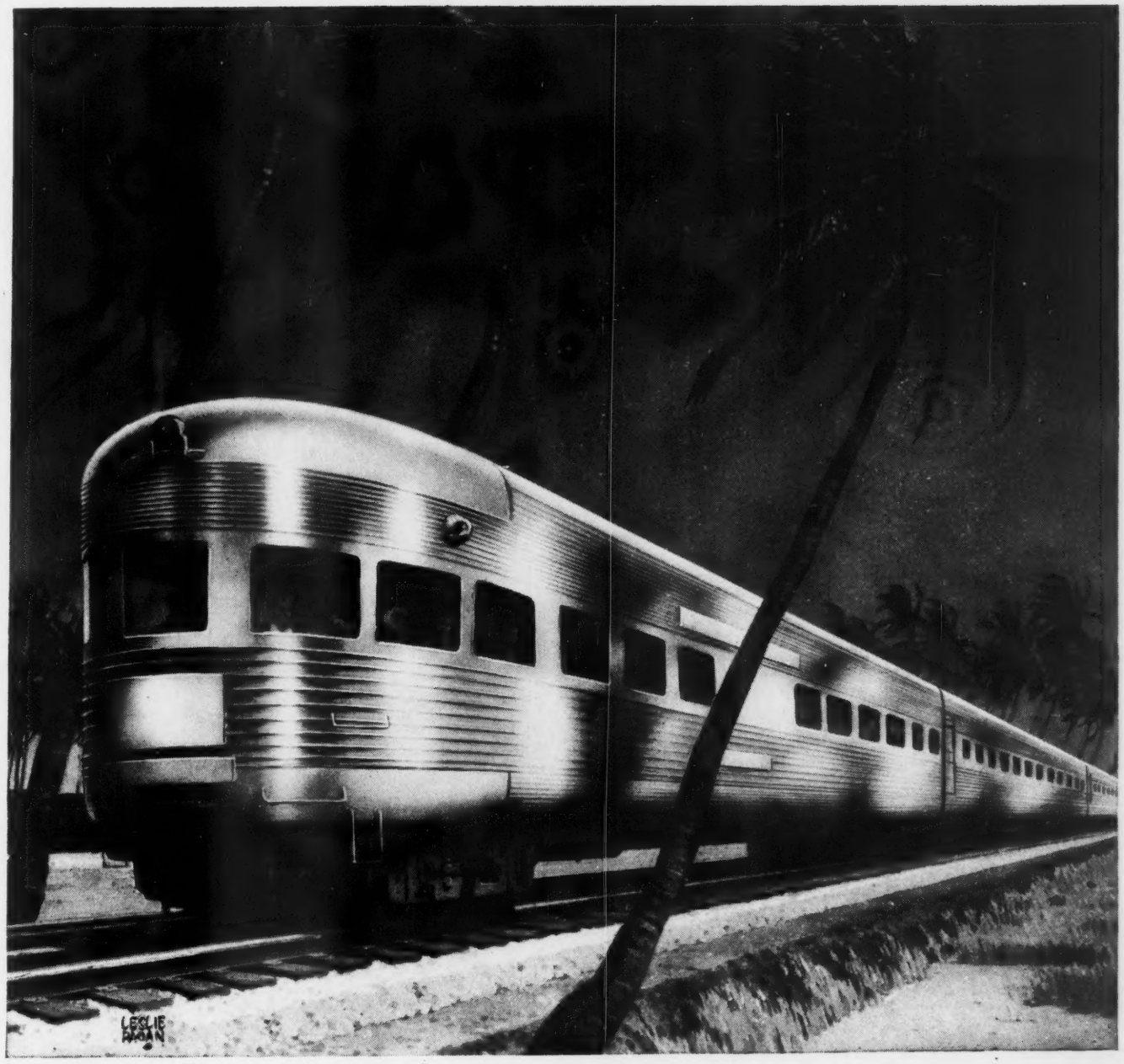

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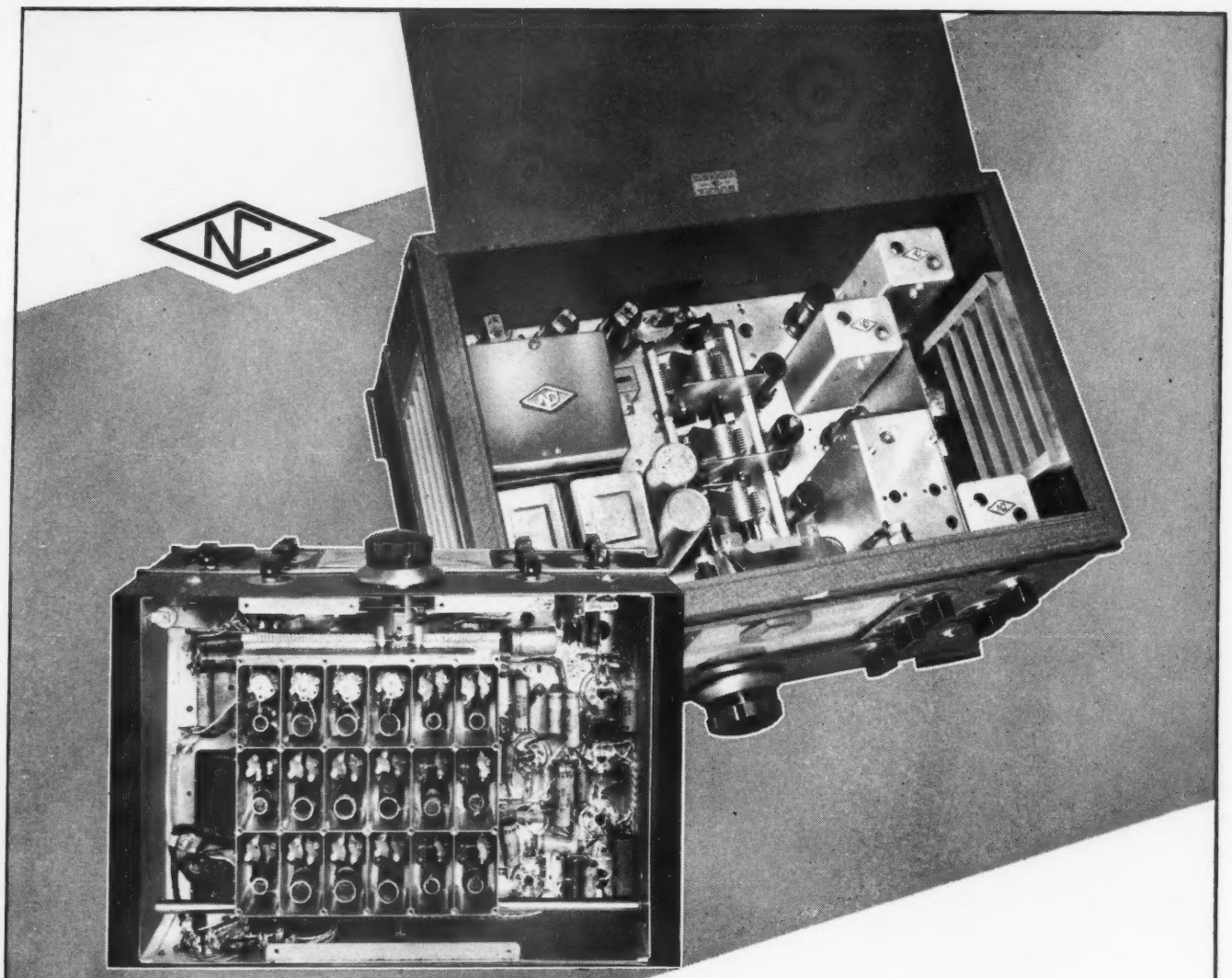

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The TECH ENGINEERING NEWS

PROFESSIONAL JOURNAL OF THE UNDERGRADUATES

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Volume XXVIII, No. 2

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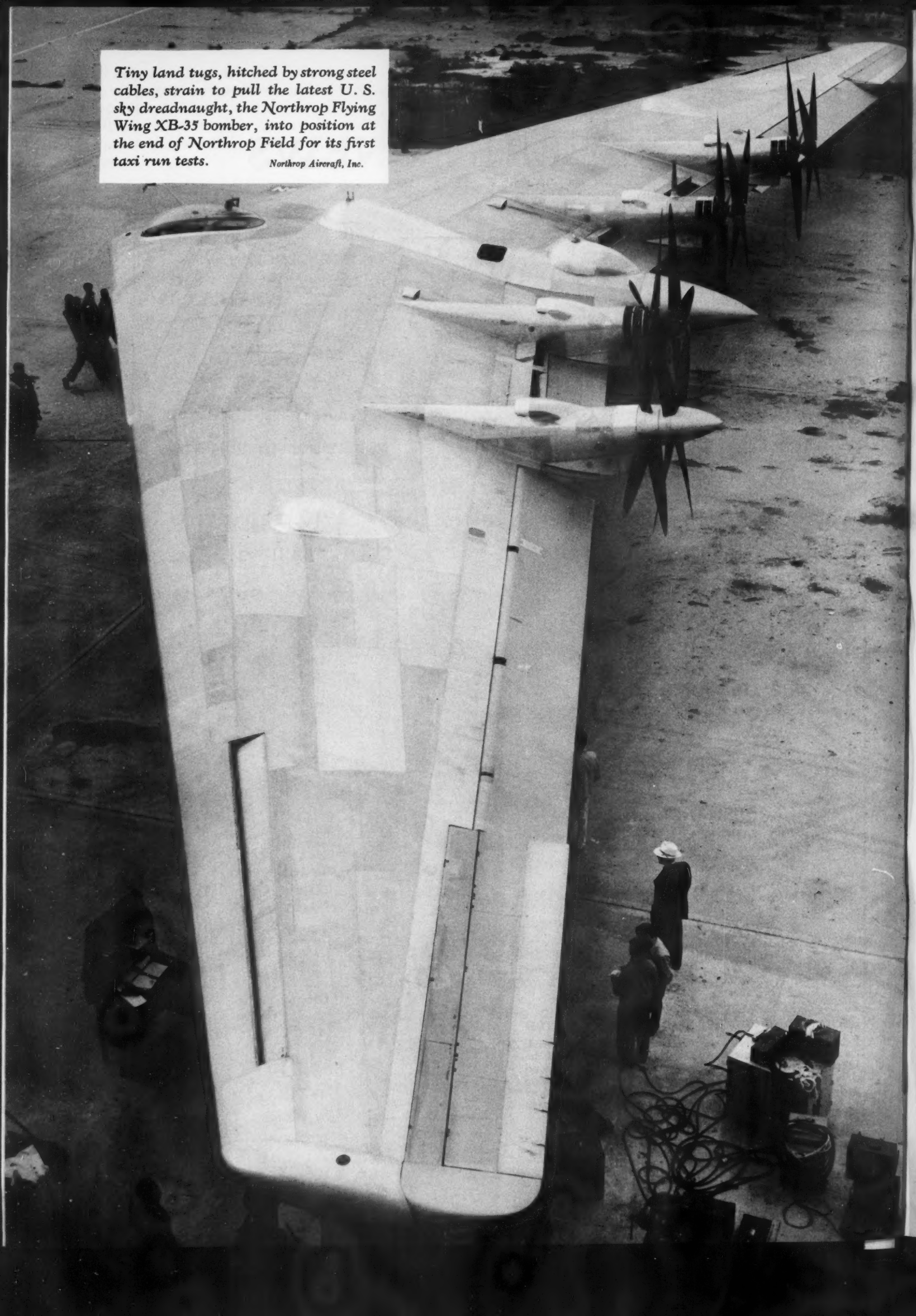


Tiny land tugs, hitched by strong steel cables, strain to pull the latest U. S. sky dreadnaught, the Northrop Flying Wing XB-35 bomber, into position at the end of Northrop Field for its first taxi run tests. *Northrop Aircraft, Inc.*

XB-35, Giant Wing

BY GUIDO J. FRASSINELLI, '48

WHEN the Northrop Flying Wing XB-35 Bomber took off from Northrop Field in Hawthorne, California, last June, another milestone had been reached in aviation. Some observers, on the basis of the XB-35's performance, foresee in the not-too-distant future 100-passenger all-wing transport planes cruising at 500 mph; freight planes cutting shipping costs to half their present level; and bombers capable of bombing any spot in the world.

The XB-35, which has been in construction since early 1943, is an all-metal, full-cantilever, tailless, four-engine bombardment-type aircraft of true all-wing design with controls incorporated within the wing. Crew capacity is 15 men, a normal crew of nine and a relief crew of six men to serve as alternate crew replacements on the 10,000-mile hops of which the XB-35 is capable. Empty, the wing weighs 45 tons. Gross weight is 81 tons, and overload gross weight is 105 tons. The span of the XB-35 is 172 ft.; length, 53 ft. 1 in.; overall height, 20 ft. 1 in.; root chord, 37 ft. 6 in.; tip chord, 9 ft. 4 in.; propeller clearance, 9 ft. 8 in.

Power comes from four Pratt and Whitney Major Wasps, one pair each of R-4360-17 and R-4360-21 series, equipped with single-stage General Electric turbo-superchargers, with a normal rating of 2500 hp., and military rating of 3000 h.p., at an altitude as yet unspecified (censored).

For propellers, the craft has four eight-bladed coaxial Superhydromatic Hamilton Standards of diameter 15 ft. 4 in. Reverse pitch, which provides a braking effect, may be employed to reduce the landing run. The landing gear, fully retractable, is of the tricycle type, with dual wheels 5 ft. 6 in. in diameter on the main gear and a single wheel 4 ft. 8 in. in diameter on the nose gear.

Stability of the XB-35 was not so hard to attain as many imagined it would be. Longitudinal stability poses no great problem if the CG is properly located with respect to the CL and the proper airfoil sections are used. Allowable shift of the CG on the XB-35 is surprisingly large. As on other wing type aircraft, sweepback is used on the XB-35 to insure proper balance rather than stability. The tendency of swept-back wings to stall at the tips first at high angles of attack, which induces a dangerous nose-up effect, provides a serious problem in longitudinal stability.

On the XB-35, this problem is solved by providing tip slots with automatically operated doors (which are closed at high speeds to maintain the smooth contour of the wing) which open when the speed becomes less than 140 mph, bringing the slots into action and preserving lift at the tips beyond the angle at which most of the wing stalls.

The effective dihedral resulting from sweepback, and one degree of built-in dihedral, provide the necessary lateral stability.

Directional stability also depends considerably on sweepback, which gives a "weather-vane" effect which is adequate for all practical purposes, although it may not satisfy current standards for stability. There is, however, no need for vertical stabilizing surfaces on the XB-35, because an adequate vertical fin effect is produced by the four propellers, which, located well behind the CG, have a directionally stabilizing action whether wind-milling or under power. Even fully-feathered, the total area of the 32 blades would cause a considerable vertical fin effect. If two engines on the same side should go dead, the XB-35 will stabilize itself in a yawed attitude, without the application of corrective rudder, because of the inherent directional stability of the swept-back wing. Such a flight attitude adds very little drag, and is therefore practical only on the flying wing type aircraft. On the jet powered version of the XB-35, vertical fins will be added at the trailing edge to provide the directional stability provided by the propellers on the original version.

Flight controls are built into the trailing edge of the wing. Next to the elevons, and extending to the wing tip, are trim flaps which are used to trim the plane longitudinally. Mounted on the trim flaps are power-operated rudders of the split flap type which provide drag for directional control. The two elevons, each of span 34 ft. 6 in., are moved together for elevator effect and differentially for aileron effect.

The landing flaps, which occupy the center portion of the trailing edge, are more than 29 ft. long by about 6 ft. wide each, with a total area of approximately 175 sq. ft. The pitching moment they produce is counteracted by the trim flaps at the wing tips which move up as the landing flaps are lowered. Although it is not as yet possible to obtain as high a trimmed $CL_{max.}$ on the XB-35 as on conventional airplanes, the minimum drag is so much less than that of conventional aircraft, that the ratio of $CL_{max.}$ to $CD_{min.}$ is improved by about 50 per cent. Research on various types of lift devices should bring about further improvement.

A full boost hydraulic system was installed to enable the pilot to move the controls. This was coupled with a Northrop-designed "feel" system, which puts automatic pneumatic loads on the controls. Without the "feel" system the pilot could move the booster controls sufficiently with two fingers to tear off the control surfaces. The "feel" system applies pneumatic forces, varying at different speeds, to the controls, to hold control movement within the limits of safety. The hydraulic system (of the medium high pressure type) provides about 2,000 lb. pressure, and uses 92 hp., more than most personal light planes have, to operate the eight hydraulic pumps.

The electrical system which is used to operate the landing gear, landing gear doors, gun turrets, bomb bay doors, and other equipment, is of the 400-cycle, three-phase, 208-volt type, and is one of only two such systems used in an airplane. The four alternators, geared to the Wasp engines, turn out 120 kilowatts per hour, more than enough to supply 1,000 average homes. The XB-35, one of two giant bombers to use alternating instead of direct current, can use lighter wiring and thus save weight. Direct current must be carried by thicker and heavier wires, which adds up to considerably more weight when you are dealing in ten-mile lengths such as those used in the XB-35 to link the four alternators to the lights, radio, and dozens of electric motors which operate the pieces of equipment mentioned above.

Structurally the XB-35 incorporates three major elements in one homogeneous unit. The crew nacelle, located at the wing center, of semi-monocoque con-

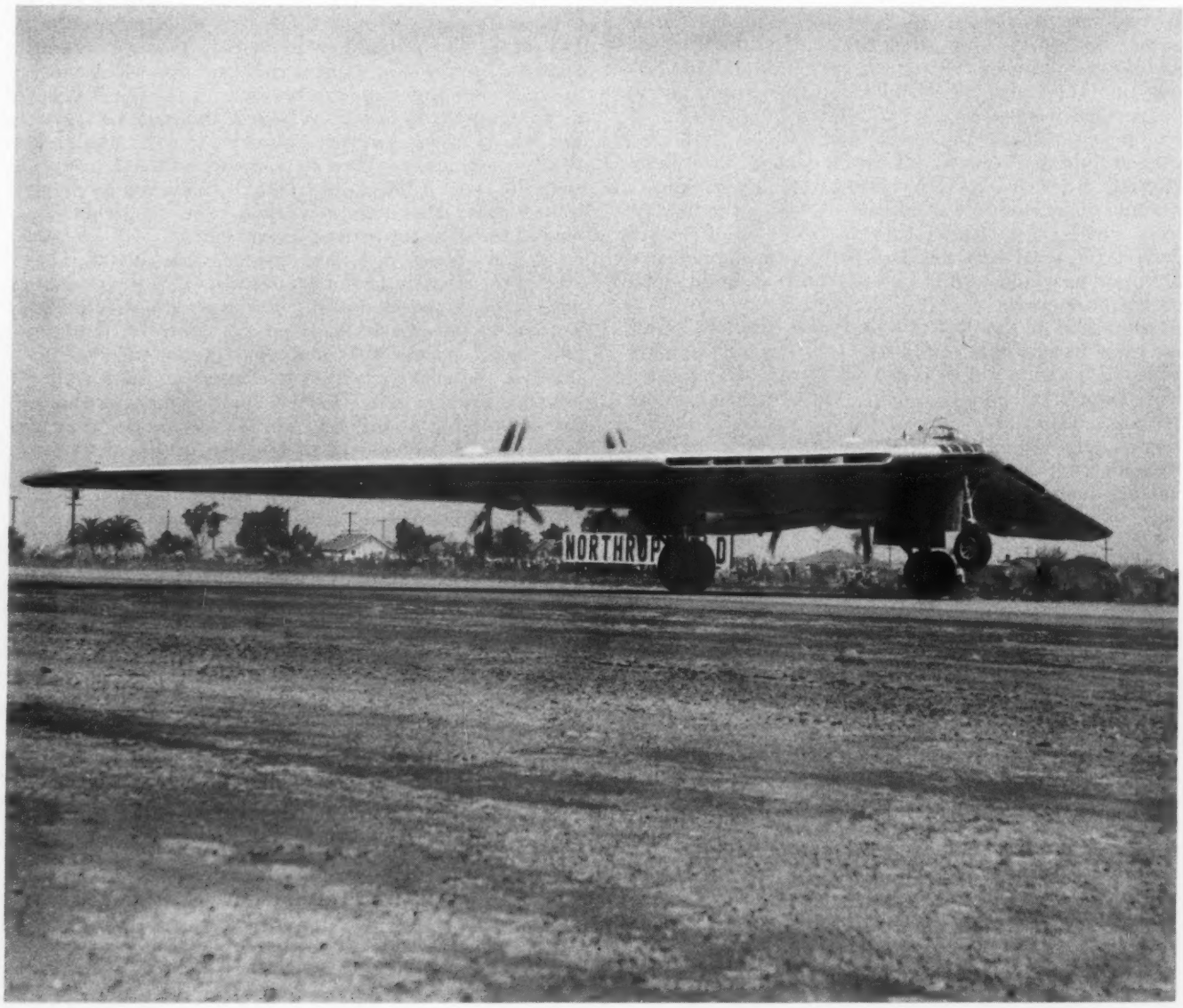
struction, is basically rectangular in cross-section, and is able to withstand pressurization effects. The thickness of the plexiglas windows varies from 3/8 to 11/16 in. In the XB-35, all major loads are borne by the stressed skin, which is mostly of the 75S aluminum alloy recently developed by Alcoa. It varies in thickness from .020 to .091 in., the maximum being used at the leading edge section. The inner wing section, extending from the crew compartment to outboard of the engines, has two main spars, the upper surface of the wing being stabilized by hat-section 75S stringers. The underside of the inner wing section is almost entirely open between the front and rear spars, with roll-away doors for the four bomb bays on each side of the crew nacelle. The portion of the wing forward of the front spar acts as a torque section. The outboard wing section also uses two main spars, but otherwise is semi-monocoque, with both upper and lower surface skin strengthened by hat-section 75S stringers.

The inboard engines are located in the leading edge section, forward of the front spar, and drive the propellers by means of a three section drive shaft, each section being about 8 ft. long. Outboard engines, which are mounted between the front and rear spars, drive their propellers through a drive shaft of two sections. All shafts turn at engine speed. Propeller gear boxes, on which the propellers are mounted, reduce the speed of the propellers. The gear boxes are placed on cantilever structural members which extend back from the rear spar.

The use of fully-submerged engines, each of which develops enough heat to warm a factory building, posed the problem of how to handle cooling air for the various elements of the engines. The answer was the "plenum chamber," which eliminates the need for many air scoops protruding from the wing, which would only impair airfoil efficiency. Instead, one long air-duct incorporated in the leading edge on each side of the wing takes in air and directs it to the plenum chamber, where the forward motion of the plane builds up pressure. Air is taken from the plenum chamber to feed the two turbo-superchargers on each engine, the intercoolers, and oil coolers, and a large flow is directed back over the wholly-submerged engine to cool it. Installation of jet power units will greatly simplify the problems of air ducting encountered in the propeller powered model.

(*Continued on page 88*)

In the first split-second of its history-making flight, the Northrop Flying Wing XB-35 long-range bomber lifts its nose into the air at Northrop Field, Hawthorne, California. *Northrop Aircraft, Inc.*



The Compounds of the Rare Gases

By LEE HANOWER, '47

CONDENSED

Introduction

In a discussion, such as this, of the compounds of a particular periodic group, the individual elements might be treated separately, or similar compounds might be grouped together. The development of this particular topic might also be made chronological. To derive the benefits of all three plans the following discussion will incorporate elements of each. A brief historical outline will be followed by treatments of the various types of compounds and finally the compounds of each element will be given in tabular form.

Historical Survey

The periodic arrangement of the elements as proposed by Mendeljeef left no place for the rare gases. The existence of these elements could not have been predicted without a knowledge of the Bohr-Thompson model of the atom. Therefore we are not surprised to learn that the rare gases were discovered almost by accident.

An eclipse in the year 1868 enabled several experimenters to use a spectroscope on the sun's corona for the first time. A bright yellow line, which was not previously known, was observed. The line, now known as D_3, was at first supposed to be due to sodium, but in 1870 Lockyer advanced the theory that the new spectrum line was due to an unknown gas.

But the actual discovery of the rare gases did not occur until 1893 when Rayleigh and Ramsay were attempting to determine the densities of oxygen, nitrogen and hydrogen with extreme precision. A discrepancy, well in excess of the possible experimental error, was noted in the values determined for nitrogen from different sources. The fact that atmospheric nitrogen was denser than that from compounds led to the discovery of the rare gases. Further research led to the isolation of other members of the group except helium. The individual elements were separated from each other by distillation. In 1895 Ramsay observed the D_3 spectrum line in a spectrum obtained from a gas from the mineral clevite. In this way helium was discovered. Radon, the last member of the group, was discovered in 1900 by Dorn and isolated in 1908 by Ramsay and Grey.

That the chemical indifference of these gases was recognized early is apparent from the name "argon" which means "without affinity" in Greek. Ramsay made a determined search for compounds of the rare gases. He circulated the gases at red heat over various materials but he was unable to detect any signs of combination. The first compound of this group was reported in 1896 by Villard. In succeeding years isolated attempts were made to find compounds of the noble gases but no new discoveries were announced until 1923 when de Forcand confirmed Villard's work and went on to announce several new compounds. Since then much work has been done in this field and the existence of several compounds of the rare gases has been definitely established.

Types of Compounds

The most fundamental characteristic of the rare gases is their supposed chemical inertia. The electron configuration of a rare gas is supposed to consist of complete shells. As they, thus, have no tendency to either gain or lose electrons, this group of elements does not form electrovalent compounds, under ordinary conditions. Ramsay, who had much to do with the early history of these elements, looked for compounds of the electrovalent type, and finding none he dubbed these gases inert.

We now realize that, while the rare gases do not enter into ordinary chemical reaction, they are capable of forming compounds. These compounds may be roughly divided into two large classes: compounds with non-metals, and compounds with metals.

The compounds with metals are for the most part helides. These compounds are thought to resemble hydrides. It is possible under conditions of electric discharge to displace one of the two electrons in the helium atom and thus leave a He ion. There is also a metastable form of helium in which one of the electrons exists temporarily in an energy level further removed from the nucleus than is usual. Either of these forms of helium is thought to be similar to hydrogen in the ability to combine with metals. Because of the exceptionally thorough work done on the platinum-helium system and similar systems by one scientist, these systems will be discussed as a separate topic. Mention will be made of amalgams although this type of compound is not important at present.

A greater variety of compounds is to be found with the non-metals. These compounds are all co-ordination compounds. They are formed at low temperatures and high pressures and are, for the most part, unstable under ordinary conditions. Two different mechanisms have been suggested for this type of compound.[1] The rare gas may act as a donor of electrons. This is thought to account for the Argon-Boron triflouride system. It is also suggested that a molecule with a dipole moment may polarize a rare gas atom and thus form a loose compound. The same author also mentions the possibility of the rare gases acting as acceptors of electrons. This is seemingly at variance with the first paragraph of this section; but the explanation is advanced that the outer shells of argon and elements of the group in higher periods may be capable of expansion. Since there is no reported experimental verification of this interesting theory, it will not be discussed further.

The Hydrates of the Rare Gases

The first compound of a rare gas to be reported was a hydrate of argon. It was reported by Villard[2] as a crystalline compound at 0° and 150 atmospheres. Years later Villard's work was repeated and his results confirmed by de Forcand[3] who also reported a hydrate of krypton. Later[4] he reported a hydrate of xenon. De Forcand's results are included in Table I. De Forcand concluded his first report by saying that the other rare gases ought to form hydrates whose stability would increase with increasing atomic weight. His subsequent discovery of the hydrate of xenon was some confirmation of this hypothesis.

But, ten years elapsed before Nikitin[5] reported the last hydrate, that of radon. In later experiments[6] Nikitin, using means similar to those with which he

obtained the hydrate of radon, obtained hydrates of neon and argon.

Nikitin obtained the rare gas hydrates mixed with the hexahydrate of SO_2. This was accomplished by allowing a measured quantity of the rare gas to stand in a vessel with sulfur dioxide and snow at $-8°$. The crystals of the hydrate were mixed with the residual snow. The hydrates were separated from the snow by washing with sulfur dioxide and carbon dioxide. The extent of hydrate formation was measured by the disappearance of the rare gas. When an argon-neon mixture was tried in the apparatus some neon went into the residue along with the argon hydrate. This was interpreted as evidence of the formation of a hydrate of neon.

By regulating the experimental conditions, Nikitin found that he could use the differences in the stability of the hydrates as a means of separating the gases from each other. Both radon and argon could be separated quantitatively from mixtures by this method.

TABLE I

Compound	*N*	*Vapor Pressure Temperature*	*Vapor Pressure Pressure*	*Heat of Formation*	*Critical Temperature*
$Ne{\cdot}n(H_2O)$	6	.....	.....		
$A{\cdot}n(H_2O)$	5.14–5.50	0.0–0.4 8	98.5 210	14,855	
$Kr{\cdot}n(H_2O)$	5.08	4.0 4.8 10.3 12.5	14.5 23.5 38.7 47.5	14,712	12.5–13.0
$Xe{\cdot}n(H_2O)$	6–7	0	1.4		24
$Rn{\cdot}n(H_2O)$	6	0	1		

Note: Pressures are in atmospheres, temperatures in °C. and heats of formation in calories.

De Forcand's prediction relating to the stability of the hydrates of the rare gases is substantiated by the data in Table I. The dissociation pressures at 0° are seen to decrease until radon hydrate is stable with a dissociation pressure of one atmosphere. The two critical temperatures cited are also evidence of increasing stability. With this generalization regarding stability in mind it is not difficult to understand why no hydrate of helium has been reported. This compound is undoubtedly not stable under the conditions of temperature and pressure so far used. Neon hydrate is also too unstable to be isolated. Nikitin[7] reported that when an argon-neon mixture was used in his apparatus less than four per cent of the neon could be made to combine.

Addition Compounds with Phenol

Noting the similarity between radon and substances such as hydrogen sulfide (see Table II), Nikitin[7] reasoned that radon should form a compound analogous

TABLE II

	Critical Temperature	*Critical Pressure*	*Boiling Point*	*Melting Point*
Radon	104.5	62.4	−62	−71
Hydrogen sulfide	100.4	89.05	−60.7	−85.6

Note: Pressures are in atmospheres and temperatures in °C.

to the addition product of phenol and hydrogen sulfide. Powdered phenol at $-35°$ reacts with hydrogen sulfide. The reaction will proceed at room temperature if seeded with the product $H_2S{\cdot}PhOH$.

He found that radon would not react directly but that the addition product could be formed in the presence of the H_2S product. Three different ways of carrying out the reaction were mentioned in the article: Exposing $H_2S{\cdot}PhOH$ to air containing radon and recrystallizing several times, crystallizing hydrogen sulfide with radon and then recrystallizing both at $-15°$ as the PhOH addition products, forming the hydrogen sulfide addition product directly in the presence of radon.

The Bertholet-Nernst distribution constant is said to check for the material prepared by each of the three methods. This is taken as evidence for the formation of $Rn{\cdot}2PhOH$. The melting point of the compound is estimated to be around 50°. Argon also formed an addition product but the distribution ratio is very much smaller than that for radon.

In a later experiment[9] Nikitin put some dry, powdered phenol into a five milliliter evacuated U-tube and filled the tube in successive trials with argon, krypton, and xenon. A manometer was attached to the tube to show both the start of the reaction and the dissociation pressure of the compound. No compound formed with a pressure of one and a half atmospheres and temperatures from room temperature to $-185°$ C.

In another set of experiments, he added hydrogen sulfide at $-50°$ to the tube containing phenol and formed the addition product. Then xenon was admitted and evidence pointed to the formation of $Xe{\cdot}2PhOH$. The amount of xenon ranged from fifty to one hundred times the amount of hydrogen sulfide used. The following values were obtained for the dissociation pressure:

Pressure (mm.)	115	195	340	630	760
Temperature (°C.)	−30	−20	−10	0	4

This xenon compound is more stable than the xenon hydrate. This is apparent from the dissociation pressures at 0° which are 630 mm. for the phenol compound and 760 mm. for the hydrate. A krypton addition product with phenol was also observed[9] and further study of this compound is promised.

The Argon-Boron Trifluoride System

In an interesting series of experiments, Booth and Willson[10] produced a whole set of new compounds — all addition products of argon and boron trifluoride. At the time that they were studying other compounds in which boron acts as an acceptor of electrons, they reasoned that even a rare gas with its completed outer shell might be induced to form such a compound. In a preliminary experiment they cooled a mixture of argon and boron trifluoride and found that compounds corresponding to the formulas $A{\cdot}8BF_3$ and $A{\cdot}16BF_3$ were formed.

They then undertook a careful study of the properties of the $A\text{-}BF_3$ system. A plot of temperature versus composition revealed a series of maxima in the melting points which were interpreted as compounds of the formula $A{\cdot}nBF_3$ where n has the values: 1, 2, 3, 6, 8, and 16

The first three compounds are probably co-ordination compounds. It is harder to explain the other three compounds. It was suggested that the excess BF_3 molecules might be joined to fluorine atoms, or else the excess molecules might be symmetrically located in the crystal lattice.

The $A{\cdot}nBF_3$ compounds are not stable and dissociate above their melting points which range from -127 to $-129°$ C. It is conjectured that krypton and xenon will form more stable compounds of this type but no further work along these lines has been reported.

Compounds with Nonmetallic Elements

Although, under ordinary conditions, the rare gases do not form electrovalent compounds, the metastable form of helium may be capable of compound formation. This idea of Franck led Boomer[11] to search for compounds of helium and various nonmetals.

(*Continued on page 76*)

Well, What Happened To You?

BY ROBERT B. DAVIS, 9-46

SUPPOSE you were given a problem about the decomposition rate of radium, and had to solve it without the use of such tools as calculus and differential equations. Some fun! Sympathize then with the psychologist of a few years ago, who had to deal with a problem far more complex; he not only had no tools for the job — on all sides he found people who were ready to attack any tools he might develop. If his approach was experimental, it was said that he had no logical justification, no adequate theory behind his work. If he spent his time working on theory, it was said that he had a psychology that could not be applied to people. If he combined the two, he was told that he had made his facts fit his theory. Freud said that he was credited with the "discovery" of his theories only when they were being refuted.

One of the fundamental methodological discoveries that fought its way through this confusion is the topic of this article: a person is the product of heredity and environment. Physiology deals with heredity; psychology considers environment. This is not a definition of psychology, but rather a description of a fruitful method of approach. If you want to know why J. L. cannot stand blondes, study his "case history"; find out about the blonde who led him on for eight months and then left him cold. Then you will know why J. L. cannot stand blondes.

Our general method of approach is now clear. But we shall need something more. Without some specific knowledge of the working of environment, we shall never be able to understand certain problems. Two of the worst would be "association," and what Freud first called the "censor." Examples of the following type are quite well known: a man finds that he can handle all of his work with no difficulty — except for one thing. He cannot stand interviews with a certain type of superior. He becomes nervous, cannot keep his mind on the problem at hand, cannot offer helpful suggestions, makes a bad impression. Something has to be done. He is really competent, yet the boss naturally thinks him a bungling idiot. Can our "case-history" method offer him any assistance? In almost all such cases, it can. We are not concerned here with the method of treatment, but are instead merely interested in diagnosis. The psychoanalyst finds that the patient was very hostile to the authority of his father. Without some specialized knowledge of such cases, this might be all that the psychoanalyst could find. Happily he understands the working of "association." The boss is in a position strikingly similar to that of the patient's father. By association, the boss *is* father. Father has authority; this authority is bad; I am afraid of father; the boss has authority; the boss is father; the boss is bad; I am afraid of the boss. This, of course, is not an attempt at logic. It is merely a verbal outline of the nonverbalized working of association.

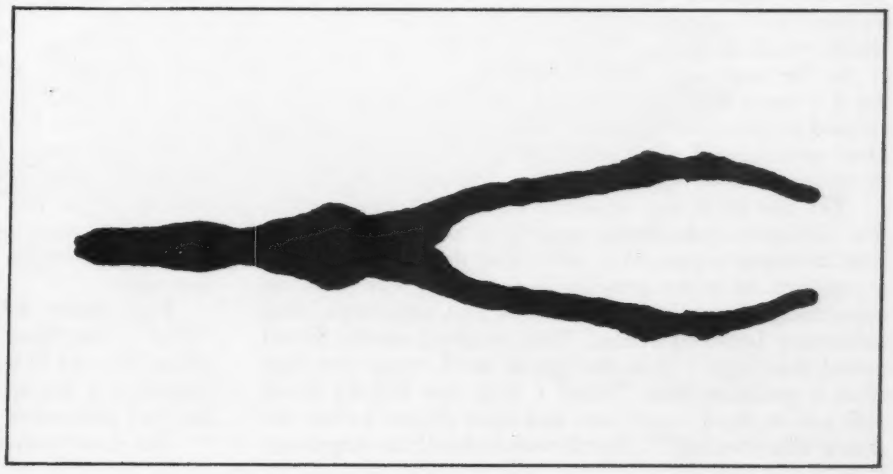
Those who saw "Spellbound" are familiar with excellent examples of association and of the "censor." The hero, as a child, had accidentally killed a younger brother; while sliding down a sloping roof he had struck the brother, who was sitting on the edge, and pushed him onto a spike-topped fence. This incident had been completely forgotten. Later, while skiing with a companion, the hero saw the companion shot and killed, later claiming that he had killed the companion himself. In a dream, the hero saw a murder by the head of a gambling house, where the players resembled the patients at a particular sanitarium.

Again, without a satisfactory approach, we can hardly hope to penetrate this maze of fact and fancy. Why should an incident so important as the death of a brother be forgotten? This, Freud would say, was the working of the censor. The incident was too painful to remember, so the mind protected itself by forgetting. While the patient was awake, the censor gave complete protection, and even when the patient slept, the censor permitted the memory to appear only in disguised form. The skiing incident resembled, by association, the death of the brother. Had the skiing incident been remembered, it might have led to remembering the brother incident. The censor would not permit this. Hence the skiing incident was forgotten. When it came to a choice between remembering or confessing to the murder of the companion, the censor again intervened, and the hero confessed. In his sleep, however, he was able to see the skiing incident in disguised form. Just as the boss became father, the head of the sanitarium, who had committed the skiing murder, became the head of a gambling house, and committed a crime that did not resemble the death of the brother so closely as the actual skiing murder had. This illustrates rather accurately the working of the censor and of association.

We now give a more scientific formulation of the method of approach outlined above.

To begin with, we assume that the law of cause and effect holds for psychology. Thus if an ink spot that looks to most people like a dancing girl looks to you like a valve on a fire-sprinkler system, there must be some reason for it. (Perhaps you went to Tech.) Freud put it this way: "The gods do not speak through the mouths of men." Hence, if the psychological explana-

Figure 1



tion of behavior seems at times to be ridiculously complex, it is still valuable as the simplest explanation that we know which satisfactorily relates cause and effect.

The child is born with certain "direct" desires. These include the obvious physical desires. As he grows up, they come to include also such desires as the desire for attention. These desires Freud grouped together and called the "Id." You can easily guess that these desires alone make for trouble. The young child does in fact experience such trouble. Gradually this body of "trouble" becomes too painful to remember. It is, as we have seen, forgotten. But it is not gone! The death of the brother in "Spellbound" was forgotten, yet it still had the power to make a man confess to a crime that he had not committed. This body of forgotten-but-not-gone trouble, Freud called the "Super-ego." It is clearly something like the conscience. When you start to do something "bad," the super-ego interferes with a concealed reminder of what happened the last time you tried something like that. Of course, you can object that your conscience would keep you from committing a murder, even though you have never had an experience with anything like murder. The answer is rather long, unless I know enough about you personally to see at once what it must be in your case. It revolves around association.

Suppose that you are very religious. At some time you must have had an experience, probably forgotten, with the consequences of disobeying — perhaps you talked during the sermon in church. You know the Ten Commandments. You associate disobedience of "Thou shalt not kill," with the disobedience experienced before. You decide not to disobey. If you have no religious scruples over murder, it may still be that you were once caught stealing an apple. In any case, there is association between some experience that you have known, and the experience of murder, which you have not.

Is the super-ego then supreme? Fortunately not, for if it were, you would never get married after a girl refused to give you a date. You would die of starvation after getting sick on green apples. You would never go outdoors after getting your first sunburn, etc.

Yet the id is not supreme either. After the first few debacles, you learn something about when and how to make a pass at a girl. You do not *always* get a sunburn on every possible occasion. There must be something else, other than the id and super-ego, that arbitrates between them. This residual entity Freud called the "Ego." It is the ego at work when you deal with a problem like: "Shall I help the fellows finish this job, or shall I quit now and have dinner before the dance this evening?" The id wants food, the super-ego reminds you how you felt when some #*!#*! left you to finish a tough job. The ego has to rule in favor of one or the other.

Is all this "theory" of any use? Can it be made to serve any utilitarian purpose? We are not here interested in "cures," but want to explain behavior and discover causes. Clearly, if our skill is sufficient, our method will not fail us. We conclude with a rather long case that illustrates the practical application of our approach.

A woman's lover proved unfaithful. She developed a speech defect, namely, she could not pronounce certain words. She also began to terminate telephone calls suddenly. The psychoanalyst discovered almost immediately that the words which she could not utter were all words which in some way suggested either her mother, or a rival with her unfaithful lover. When she ended a telephone conversation abruptly, it was because she thought that the other person's voice might be that of a rival. This difficulty had started at the time when she had seen her lover in another woman's arms. It was also found that for years she had gone through a strange ritual in cooking eggs; she would always pass the eggs through a sieve. Although she recognized this procedure as foolish, she could not give it up. She also remembers that as a child she dreamt about her father cutting off the heads of chickens. Further, she had rejected many suitable offers of marriage because of the idea that she must not become a mother. Her lover was extremely careless toward women, showing them no tenderness, and having several mistresses whom he did not conceal from the patient.

The above data clearly require theoretical knowledge of the type that we have been trying to develop, if they are to yield anything significant. Ellery Queen himself could probably not find the solution without such a tool.

The psychoanalyst knows, however, that he is confronted with the working of association, He therefore encourages the patient to give him some free word associations. By this method he uncovers some additional data. In connection with the dream, she remembers a childhood question: "If eggs come out behind, how were they put in in front?" She also remembers with a shock that if she did not pass eggs through a sieve, she might eat a rooster's sperm.

With some difficulty (the censor at work) she recalled a childhood thought: "Girls have a penis cut off in the way that chickens lose their heads." She also described a precipitate abortion of her mother's which she had witnessed.

She later remembered an earlier case of hysterical

The illustrations show "ink-blots" (which are just that) of the type used in the Rorschack test. The purpose is to find what the subject thinks about his environment. Properly used, the test has given excellent results. Although it was impossible to get an expert to interpret the results, the test was given for demonstration purposes to two people, and the method serves to give an adumbration of the "correct" use of the test.

Subject "A" called ink-blot I a pair of pliers. This was a "neutral" response, and meant simply that the subject had often used pliers. He called ink-blot II "birds and torpedoes," which is not surprising when we consider that the birds were sea gulls, and "A" has been very much interested in naval affairs. Ink-spot III was a "rat that had been run over by an automobile." We note immediately the mechanical trend in interpretation. Further, the subject did not care to elaborate any of the interpretations, so that we may suppose that none of the ink-spots had any great emotional significance. Although this may be called an a priori *result, we might expect that, if further results should prove similar, the subject is a rather undisturbed individual with mechanical inclinations.*

Contrasted with this we have the case of subject "B," according to whom ink-spot I is "a sand bar projecting out into the sea, and my brother, my mother, and I are standing on one branch of it, with a high wind and huge breakers swirling about us." Ink-spot II was "a rocket like those in Buck Rogers," and ink-spot III was "a dead animal which someone has killed." We immediately note a tendency toward a more emotional interpretation, with emphasis on confusion and pessimism, or perhaps better, excitement. If we supplement the test with questioning of the subject, we find that he remembers a scene similar to the "sea" scene, when he watched a toy boat of which he was very fond being washed out into the ocean. As this occurred at a time when his parents were having financial difficulties, about which he knew, it may well be that the losing of the boat was a symbol for something else. In general, we are led to suspect that subject "B" is more excitable than "A," more likely to be upset by circumstances, and is, for example, more disturbed by the atomic bomb. This is not correct, but is very nearly true, for "B" does the next best thing; finding reality troublesome, he has studied mathematics — a famous form of escapism — and psychology — often called an indication of some slight maladjustment. Subject "A" is an engineer.

neurosis, which had involved the symptoms of severe lumbar pains and sporadic visual difficulties. She was even able to recall that these had been associated with similar difficulties in, respectively, a pregnant woman whom she knew at the time, and in an older woman who was at that time dying. She recalled the thought that if this woman should die, she would care for the dead woman's children as her own.

From what we know about association, we can now clear up part of the mystery. To want children was associated with wishing another woman dead; this was not to be; hence she must not have children. The rejection of the suitable offers of marriage is thus fully explained; and it was then possible to effect a cure.

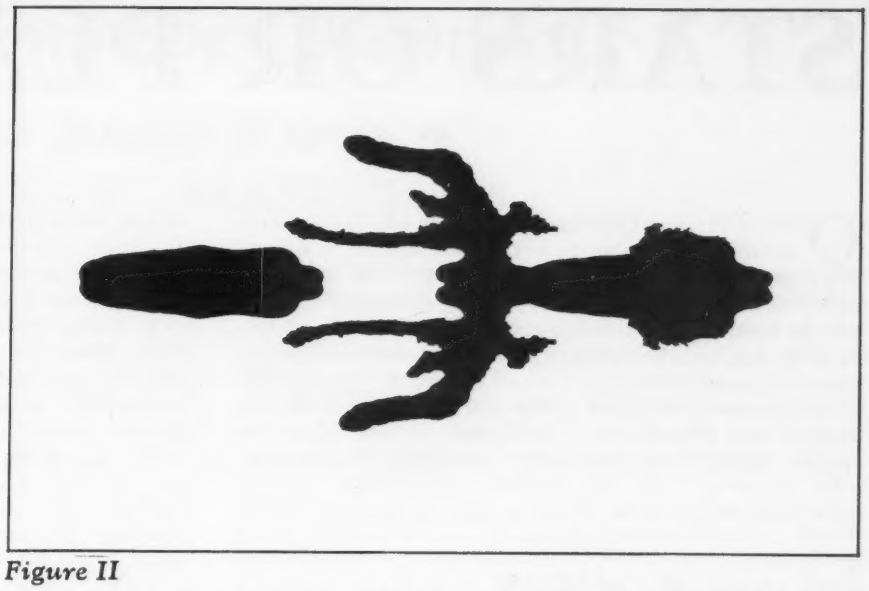


Figure II

The remainder of the mystery was explained when the patient recalled the following incident:

She had overheard a quarrel between her parents. She had recognized this as a love scene that had turned into a fight (by intuitive perception). She remembered that her father had rushed out and shaken her. Then she recalled that this was not true. It had been her mother whom her father had grabbed by the neck and shaken. She had, however, wished that he would do it to her.

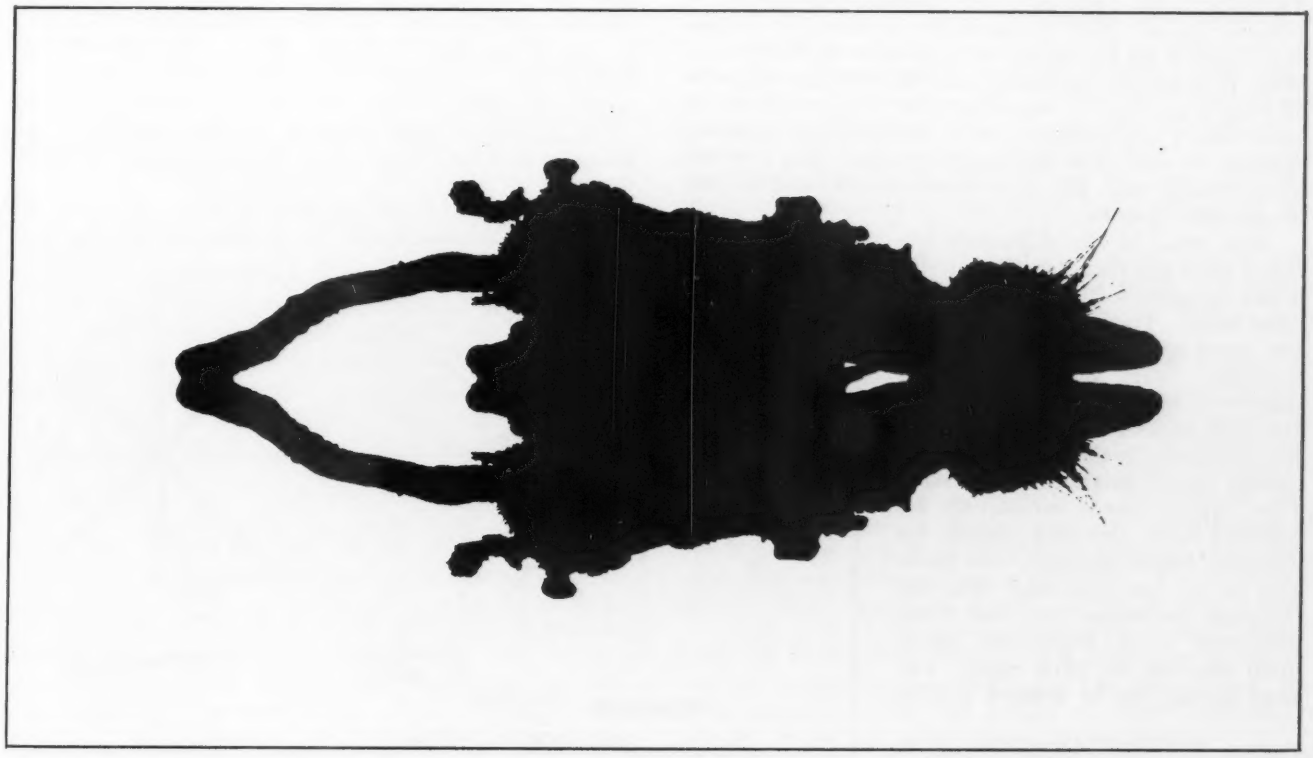
The psychoanalyst, again using his knowledge of association, was able to piece everything together. "Father gives mother babies (remember the abortion which she had witnessed) by grabbing her (like the chickens) about the neck and shaking her. I want him to do it to me. I hate mother because he does it to her!"

It was now clear why she had chosen the man whom she apparently should have rejected; he fitted her childish picture of the ideal mate. He was her "dream man." Like her father, he was continually leaving her for another woman. She could not leave him, because of the unconscious need to live this experience over and over. Thus she was able, subjectively, of course, to get what she wanted by the neurotic symptoms which had caused her to consult the psychoanalyst. By not saying words reminiscent of mother, the existence of mother was denied. Similarly, she refuted the existence of rivals with her dream man, by not talking on the telephone with anyone who might be such a rival.

In case all this sounds fantastic, may I add that the woman was cured.

The example is from "Facts and Theories of Psychoanalysis," Ives Kendrick M.D., New York, Alfred A. Knopf, 1941.

Figure III



STARS OR PLANETS?

BY PETER B. NEIMAN, '49

ONE of the most fascinating results of recent astronomical observations is that pertaining to binary systems. For a long while it was known that a few so-called stars were, in reality, binary systems; that is, two or more bodies revolving about each other. A few of these can be resolved into separate stars with binoculars or a small telescope. One of the finest for observational purposes is Mizar in the constellation of the Big Dipper (see Figure 1). A good pair of binoculars will resolve Mizar into two rather beautiful companions.

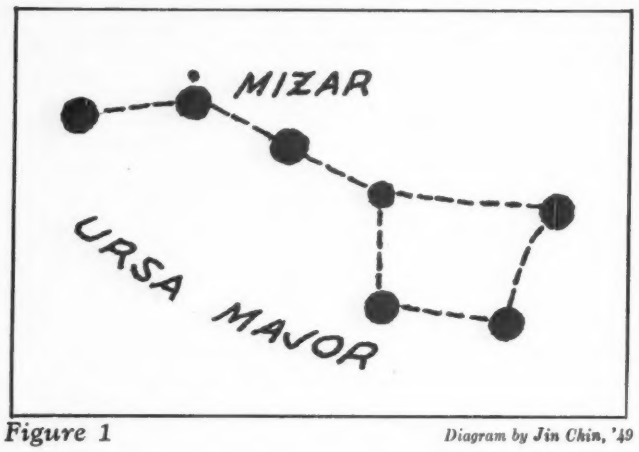


Figure 1 *Diagram by Jin Chin, '49*

Recent advances in the art of telescope making and precision instruments have shown, that contrary to former belief, the vast majority of stars are binary systems. As a matter of fact, there is only one star in the heavens that is known definitely not to be binary. That star is our own sun! The thought that life as we know it exists solely on satellites of the only known single star is an absorbing one, open to much speculation. It is partly for this reason that an investigation of binary systems is important, for if components of some binary stars happen to be cool, though massive, planets, instead of fiercely burning stars, then it is not inconceivable that life as we know it can exist outside of our solar system.

Just what is the difference between stars and planets? The answer is not definite, for many borderline cases exist. There are, however, a few more or less fundamental differences. Stars are self-luminous spheres of compressed incandescent gas, with masses comparable to our sun. Planets, on the other hand, are usually much smaller solid bodies. They shine almost exclusively by reflected light. Our own planets, for instance, which although were probably at one time extremely hot, and therefore luminous, are now comparatively cool, depending solely upon the sun for their light. The word planet can be defined outside of our solar system, as a *dependent* of a star, that is an object of very small mass compared to its primary, and revolving around the latter.

The most obvious way of detecting binary systems is by visual resolution of a star into its components. This works for binaries with stellar components of photographic magnitudes, for both stars are then easily detectable. Resolution of a *planetary* component of a binary is not as easy by visual methods. Suppose that a star such as Alpha Centauri, which closely resembles our sun, had a planetary component about the size of Jupiter, the largest of the sun's planets. The mass ratio of Jupiter to the sun is 1/1047. Since even the most powerful telescopes cannot resolve a star into anything more than a blob of light, a planet similar to Jupiter, or even one ten times its diameter, would be impossible to detect. If such a planet were near enough to the primary to reflect with a detectable brilliance, it would be in the glare zone of the primary, and hence invisible. Conversely, if it were out of this zone, it would be too far away to reflect with detectable brilliance. The probability of *seeing* a planetary component is nil. Since the vast majority of *stellar* components can be seen, the definition of a planet could be extended to a dark, invisible dependent of relatively small mass. Experiment has shown that an object must be within 1/20 of the sun's mass in order to be visible by its own light. The value of 1/20 of the sun's mass could therefore be a definition of the borderline between stars and planets.

Binary systems with unseen components can be detected by their gravitational effects on known stars or stellar systems. This so-called Perturbing Effect[1] was first put to use in our own solar system. The presence of Neptune, for instance, was determined by Adams and Leverrier by the perturbation of Uranus, in excess of that accounted for by the presence of Saturn, the next innermost planet. This excess eccentricity of Uranus' orbit could only be accounted for by

[1] A disturbance of the regular motion of a celestial body produced by some force additional to that which causes its regular motion.

(*Continued on page 80*)

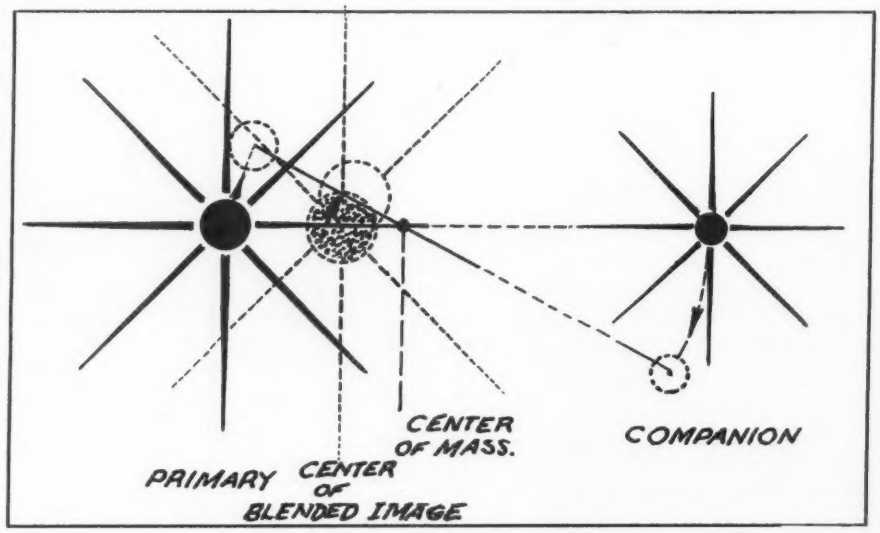


Figure 2 *Diagram by Jin Chin, '49*

Automotive Chemicals

BY ALVIN J. SITEMAN, '48

PART II. BRAKE FLUIDS

THE movable parts of an hydraulic brake system operate to transmit fluid pressure to move the brake shoes into contact with their drums. Metals and rubber are used in this system, both exposed to the brake fluid, and have working frictional contact surfaces which must be lubricated by the brake fluid. Hydraulic brakes must remain serviceable between extreme conditions of overheated brake drums or motor and subzero weather of $-40°$ or $-50°$ C.

At the present time there are many brake fluids on the market, but during the early years of hydraulic systems simply glycerine or castor oil was used, sometimes thinned with ethyl alcohol. The following analysis includes the majority of brake fluids now on the market:

Castor oil-ethyl alcohol mixtures.

Castor oil-methyl alcohol mixtures.

Castor oil-diacetone mixtures.

Castor oil-Cellosolve (ethylene glycol monoethyl ether) mixtures, with and without glycerol and glycols.

Castor oil-butyl alcohol-glycol mixtures. (In one such product the vehicle for the castor oil is a mixture of butyl and amyl alcohols, probably by-products of methanol synthesis.)

Special processed fluids having unusual properties and complex secret composition.

Glycerol-ethyl alcohol mixtures.

Glucose-ethyl alcohol-water mixtures.

Many hydraulic brake fluids have been patented over a period of years and many of them lack essential properties. Among the requirements are:

1. It must assure year-round operating performance.
2. It must function in subzero weather.
3. It must amply lubricate the system over the operating range of temperature.
4. It must maintain chemical characteristics after long use.
5. It must maintain its high operating temperature characteristics.
6. It must mix with other approved liquids.

It must not:

1. Evaporate rapidly or boil at too low a temperature.
2. Corrode or rust the system.
3. Cause rubber cups or hose to swell or deteriorate.
4. Form gummy or solid residue.

Castor oil is the only commercially available oil, animal, vegetable, marine, or mineral, that is suitable as a lubricant in, or to impart "body" to, brake fluids. Other fatty or mineral oils cause rubber to swell and soften. Disregarding other properties such as viscosity, solidification point, and tendency to dry and oxidize, the action on rubber determines whether or not an oil is suitable for use in brake fluids. Fatty acids of all kinds soften rubber and they must be free from approved brake fluids. Castor oil is unique as a base due to the fact that about eighty-five per cent of its fatty acid constituents is ricinoleic or hydroxyoleic acid. Castor oil is the only fatty oil containing this acid. In addition, castor oil is a non-drying oil, has a solidification point of $-17°$ C., and will withstand high temperatures without decomposition. It is also completely soluble in ethyl alcohol and insoluble in mineral oils. However, castor oil cannot be used alone, due to its relatively high solidification point and viscosity at low temperatures; therefore, it must be diluted with the proper solvents.

The first hydraulic brake fluid, castor oil and ethyl alcohol, was invented by Loughead. Its disadvantage was volatility and corrosiveness to aluminum alloys, copper, and brass. Sherbino and Tseng used an alkali metal phosphate and potassium hydroxide and potassium arsenate to overcome the latter difficulty. Robert Fulton doubts the corrosion inhibiting action of the phosphate and arsenate which are only slightly soluble in a castor oil-alcohol mixture.

To reduce the volatility, butyl alcohol, dibutyl phthalate, and diacetone alcohol have been used as a solvent for the castor oil. The boiling point of butyl alcohol is higher than that of ethyl alcohol; however, the former softens and swells rubber to a great extent. This action ruins the rubber compounds used in the piston cups. Diacetone hydrolyzes to form acetones in the presence of only a trace of moisture and acetone is an excellent solvent for rubber compounds. Some of the other solvents which have been tried with varying degrees of success include ethylene glycol monoethyl ether; ethyl lactate; hexahydrophtholide alone and with ethyl, isopropyl, or butyl alcohol; monoethyl ether of diethylene glycol in combination with triethyl citrate and/or methyl or ethyl levulinate; fusel oil with twenty-five per cent or more triethanolamine; acetyl-butyl alcohol or other ketone alcohol; and cyclohexanol or benzyl alcohol.

Among the substitutes for castor oil are glycerol, the various glycols, esters of ricinoleic acid, and glucose. A solution of ethlene glycol and "sulfurated" castor oil in water was claimed by Trotter. Doelling used mono-ricinoleate of a mono-, di-, or triatomic alcohol and diacetone. Klapproth used a concentrated solution of mono- and dipotassium phosphate with a corrosion inhibitor. The Hydraulic Brake Company patented a fluid of furfural, or some other furan derivative and glycol.

Any approved brake fluid must meet certain rigid requirements. Government specifications for heavy duty brake fluids for use during World War II were even more rigid.

The solvent requirements are strict because it determines to a great extent the chemical and physical properties of the brake fluid. It must have a minimum effect on rubber compounds used in the brake system. This requirement eliminates all organic chlorinated compounds, aromatic hydrocarbons, fractions of mineral oils, distillates from the destructive distillation of wood (exception is methyl alcohol), acetones (exception is diacetone), ketones, and turpentine. Only a limited number of the alcohols, ethers, and esters can be used. Alcohols with a boiling point about that of ethyl alcohol have an increasing swelling and softening action on rubber as their boiling points and oiliness increase. An inhibitor preventing the action of propyl and butyl alcohol on rubber make their use permissible.

The solvent must have a high boiling point and a

low freezing point. Its vapor tension must be low in order that its evaporation will be slow. A few of the following tested solvents can be used in brake fluids:

Alcohols	*Esters*	*Ethers*
methyl	butyl propionate	cellosolve
ethyl	ethylbutyl carbonate	methyl cellosolve
n-propyl	dibutyl carbonate	methyl carbitol
isopropyl	diethyl carbonate	butyl carbitol
n-butyl	amyl propionate	triacetin
isobutyl	triethyl citrate	aluminum gluconate
sec-amyl	tributyl citrate	tricresyl phosphate
hexyl	diethyl sulfate	phenyl stearic acid
octyl	methyl levulinate	methyl abietate
diacetone	ethyl levulinate	butyl stearate
	n-amyl levulinate	methyl ricinoleate
	isoamyl levulinate	ethyl ricinoleate
		butyl ricinoleate

Miscibility is a very important factor due to the large number of good and bad brake fluids on the market today. All standard fluids which are castor oil base and solvent will mix. However, none of these are miscible with the glycerol, glycol, or glucose type of fluid. The addition of the latter to a castor oil fluid will cause separation of the castor oil and solvent. The result will be to hinder the action of the brakes in cold weather. The water-alcohol-glycerol or glucose layer will move to the wheel cylinders and will not lubricate them. The castor oil will become viscous and hinder the operation of the brake system pistons. Lack of lubrication will wear the aluminum pistons and the brake shoes will lock. Thus miscibility is of the utmost importance.

There are many methods for testing the properties of hydraulic brake fluids. Viscosity determinations are carried out between 100° and 32° F. in the Saybolt Universal viscometer and at 0°, −20°, −30°, and −40° F. in the Saybolt Furol viscometer. The government requirement at −40° F. is a maximum of 2200 centistokes viscosity. Minimum viscosity at 100° F. is 4.7 centistokes and 1.5 centistokes at 210° F.

Cloud point and pour point tests are important and A. S. T. M. methods and apparatus are used. The period and rate of cooling determine the solidification point of the brake fluid; the characteristics of the crystalline mass, if crystals of oil or solvent form, affect the pour point.

The volatility can be determined by boiling point, vapor pressure, evaporation from an open vessel at 75° C., or flash point. Care must be taken in judging volatility by flash point as carbon tetrachloride, ethylene dichloride, and chloroethylene have very high flash points but are very volatile. The government specification for flash point is a minimum of 145° F., boiling point a minimum of 300° F., and boiling point change a maximum of 5° F.

The degree of acidity or alkalinity can be determined by titration or a pH meter. Here the government specification is a pH between 6.0 and 9.5. Free fatty acid would soften rubber and cast iron, steel, copper, and brass. Free alkali would dissolve aluminum alloys which compose the brake pistons.

Rubber softening and growth (swelling) tests are conducted by immersing the rubber piston cups in the fluid to be tested for a minimum of 200 hours at 75° to 77° C. Robert Fulton of Mellon Institute considers a growth of five per cent as the maximum allowable. The cups are also examined microscopically and softness, stickiness, and distortion are noted. The government specification on increase in base diameter after 120 hours of exposure to the brake fluid is a minimum of 0.005 inch and a maximum of 0.050 inch. Included in this specification of May 1945 is that no sloughing shall be apparent as indicated by carbon black on the surface.

Corrosion tests must be conducted on cast iron, steel, copper, brass, and aluminum alloys. The test pieces are merely placed in beakers of brake fluid at a temperature of from 75° to 77° C. for at least 100 hours. Most fluids are passive to cast iron and steel, with the exception of glycerol-type fluids which are very corrosive. Glycerol, glycol, and glycol ethers seriously affect aluminum and its alloys unless an inhibitor is present, Free fatty acids attack copper and brass. Due to the zinc in the brass, free alkalinity is corrosive to the alloy. The government specification is that the metal test strips shall not be pitted nor show more than a slight discoloration. The following metal weight losses are a maximum requirement:

Tinned iron, mg./sq. cm.	0.7
Steel	0.7
Aluminum	0.2
Cast iron	0.7
Brass	0.5
Copper	0.5

At the end of the corrosion tests the pH of the fluid should be between 6.0 and 9.5 according to government specifications. Fulton believes that 7.0 to 8.5 should be the requirement. In addition there should be no jelling nor more than a trace of precipitated sludge or salt.

Oxidation inhibitors must be added to castor oil as it slowly oxidizes and becomes gummy when exposed to air in thin films on metal, glass, or wood. Gumminess causes trouble in the wheel cylinders where the fluid is exposed in thin sheets to the dust of brake shoes. Tests are made of thin films on polished cast iron plates at a temperature of 110° C. and gumminess is noted. The Government requires a test of the fluid on a complete brake wheel cylinder assembly having an iron housing and aluminum pistons. A small amount of brake fluid is inserted after the parts have been thoroughly cleaned and kept in an oven for fourteen days at 158° plus or minus 3° F. There must be no rust or corrosion of the metal parts, no dry, hard or gummy residue and no substantial amount of sludge.

The government specifications require a water tolerance test. One hundred milliliters of brake fluid are mixed with 3.5 ml. of distilled water. The mixture is cooled for 24 hours at −40° plus or minus 3° F. After this period of time the mixture is inspected for evidence of stratification and/or crystallization which should not occur.

It is apparent that brake fluid must have the correct chemical and physical properties in order to guarantee safe operation of the brake system. Brakes should be checked regularly for fluid level in the supply tank and for air in the lines.

Home of the Volkswagen

The dream that swept the people of Germany — cruising along in the "People's Car" over the fine highways of the Fatherland

ONE of the repeated promises that Adolf Hitler made to the German people was a popular, low-priced car, called affectionately, for political purposes, the Volkswagen. The idea seemed in keeping with the expansion of highway facilities that was current.

A number of such cars were actually produced, but the army seemed to requisition the majority of them. Then, too, war exigencies demanded armored cars and tanks in place of joy buggies. Also, the destruction of railroads and highways prevented the transportation of coal, needed to produce synthetic gasolines and oils.

Nevertheless, here is the story of the plant that was designed to build the Volkswagen.

The plant was designed in 1936. It consisted of a large power plant, and about eighteen large wings, containing the manufacturing, administrative, and living installations. The popular idea in design seemed to be that in the case of bombing, it was better to have all the building supported by one main beam, then random bombs could only blow holes in the roofs. The probability of hitting the main beam seemed smaller; but removal of the main girder would, of course, collapse the building.

The factory was built in 1937 in Western Germany. The plant was located near a small farming community, and bordered a navigable stream. The factory did not appear on any of the maps published at this time. In keeping with the customary style of nomenclature, the factory was named KdF, which is equivalent to Strength through Joy.

Production was finally started in 1938, but it soon became apparent that the Crosley-like car would not be needed by the people as much as the army needed jeeps, ducks, and other fair-and-foul vehicles. Most of the plant's facilities were readapted to the production of the latter. Because of production difficulties, aside from an apparently incomplete grasping of mass production techniques, the best record the factory established for the Volkswagen was about twelve cars a day.

When the earnest bombing of Germany began, observation planes located the factory exactly, and sometime later, low-flying, precision-bombing planes removed seventeen of the eighteen main girders. The wing that remained was the administrative hall.

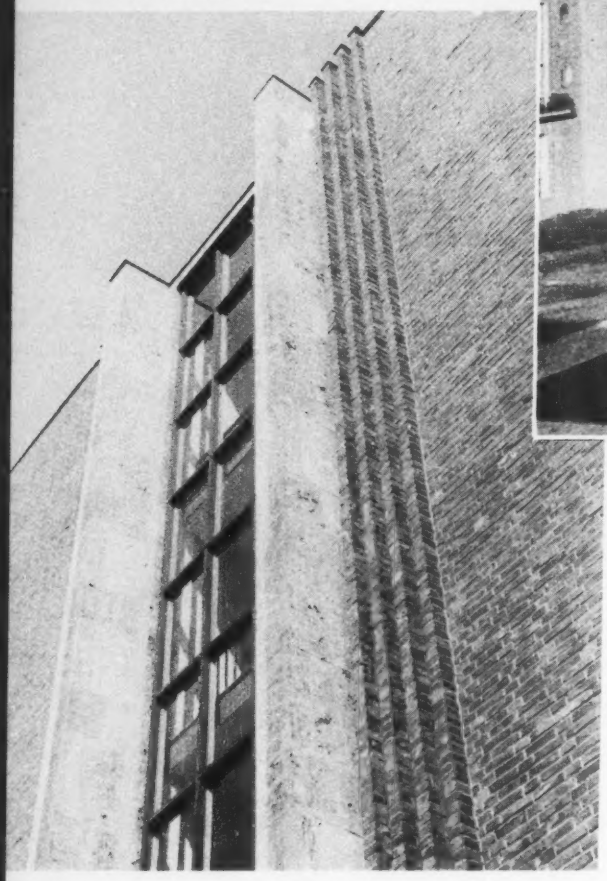
The accompaning pictures show the plant before its demolition. The pictures which we might label as afterwards, would be of interest only to archeologists and others who are concerned with weed-covered ruins.

H. L. L.

Another one of Hitler's unkept promises — the Volkswagen as shown to the German people

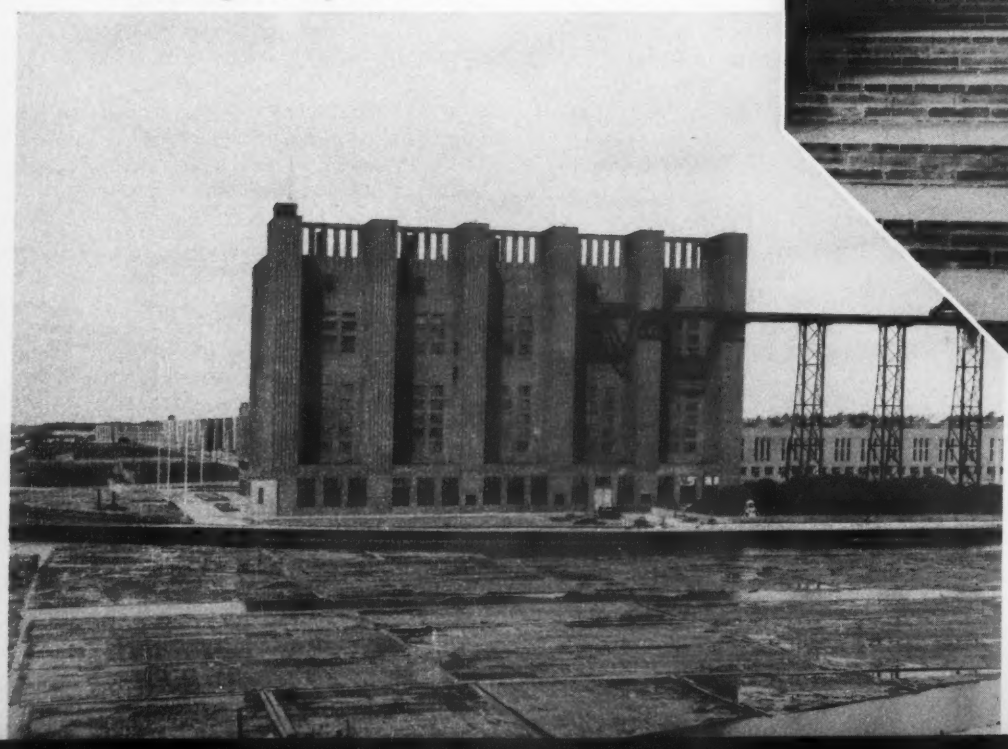
Looking down the row of wings on the factory itself towards the power plant

Outside one of the stair-wells, even here note the modern architecture

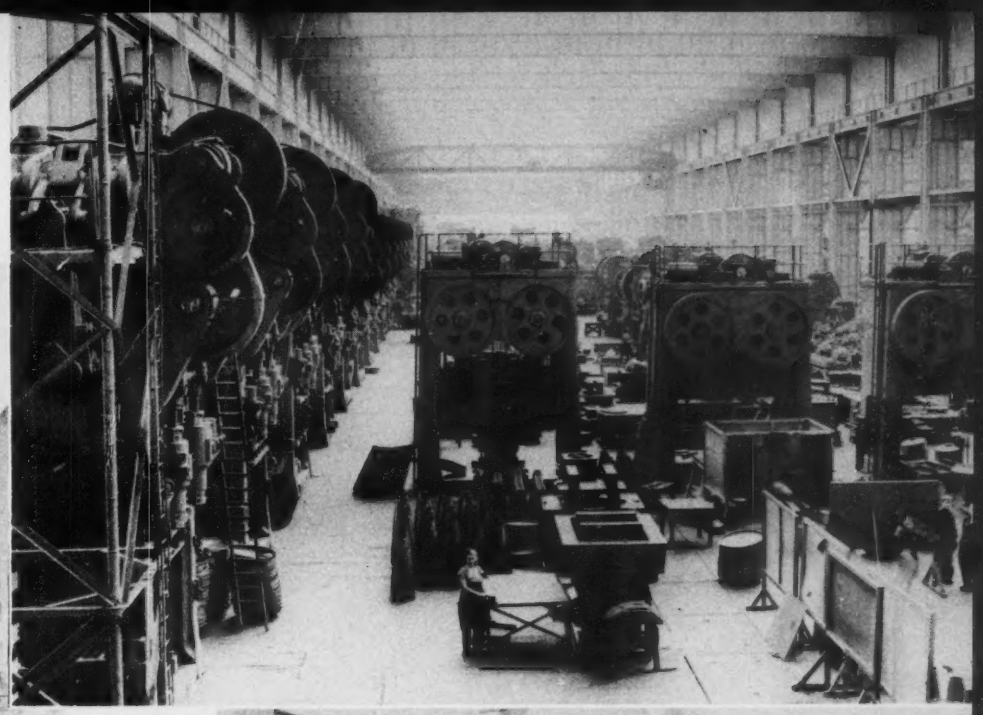


A typical stairway, white-tiled and clean

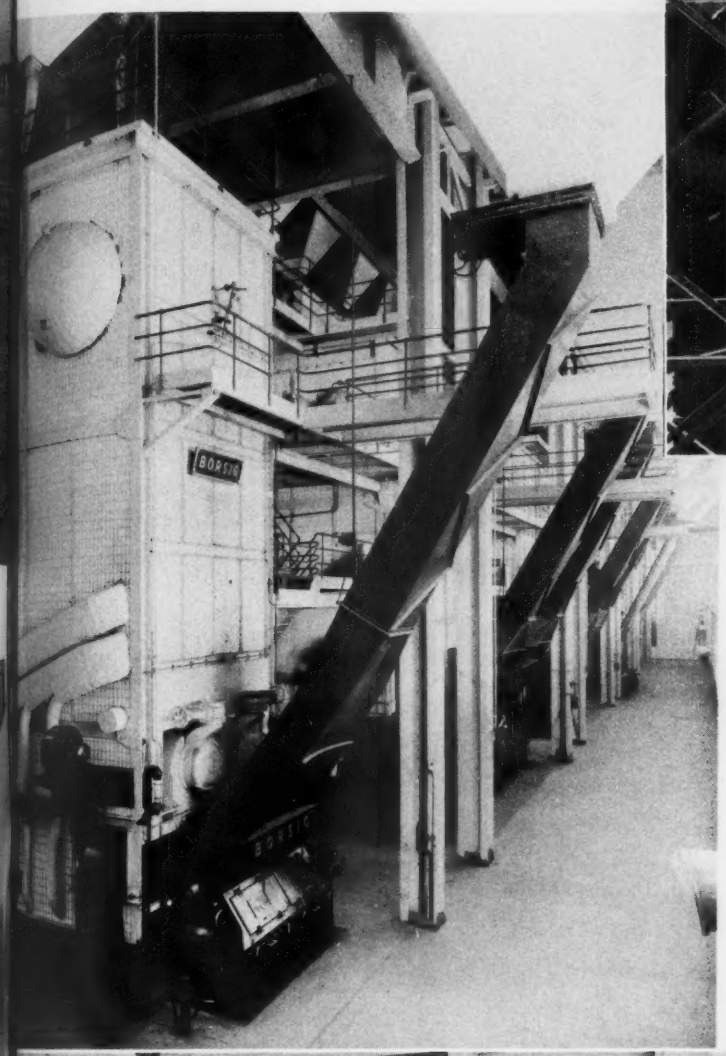
A view of the power plant, showing the adjacent canal



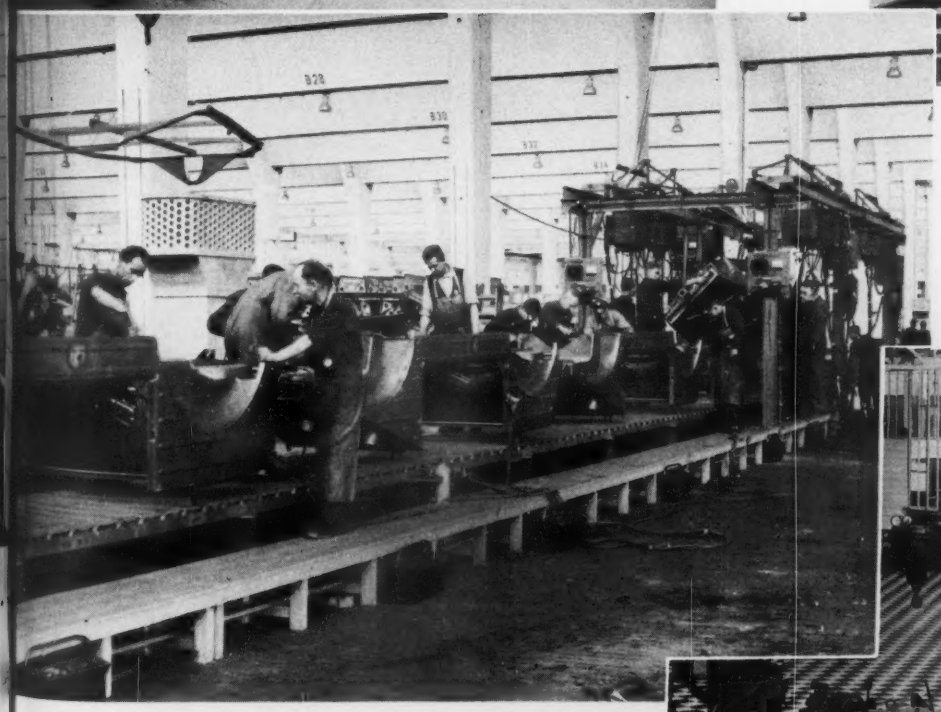
The heavy press shop where the Volkswagen began to take shape



Interior of the boiler room in the power plant

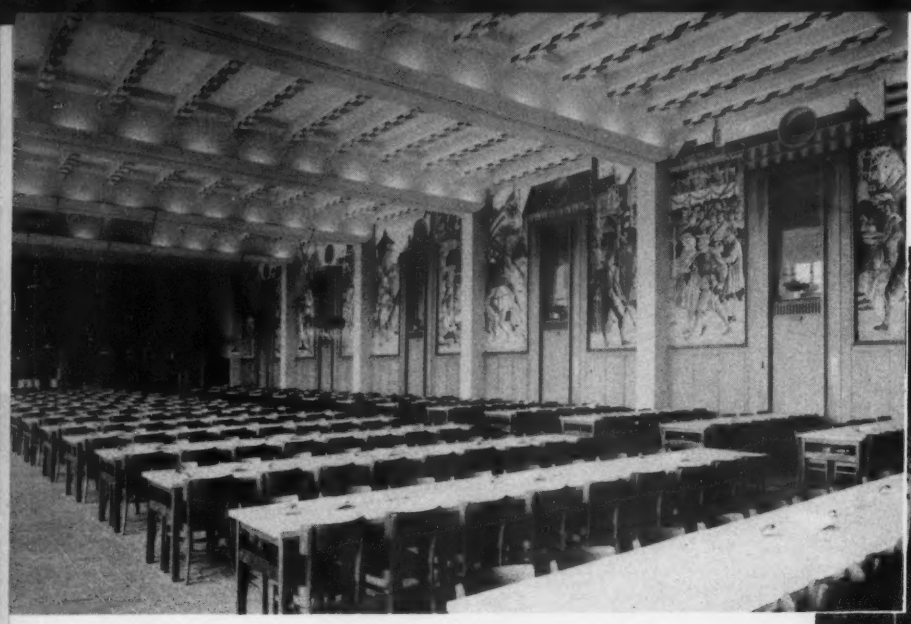


A small-parts machine shop, used for testing and gauging



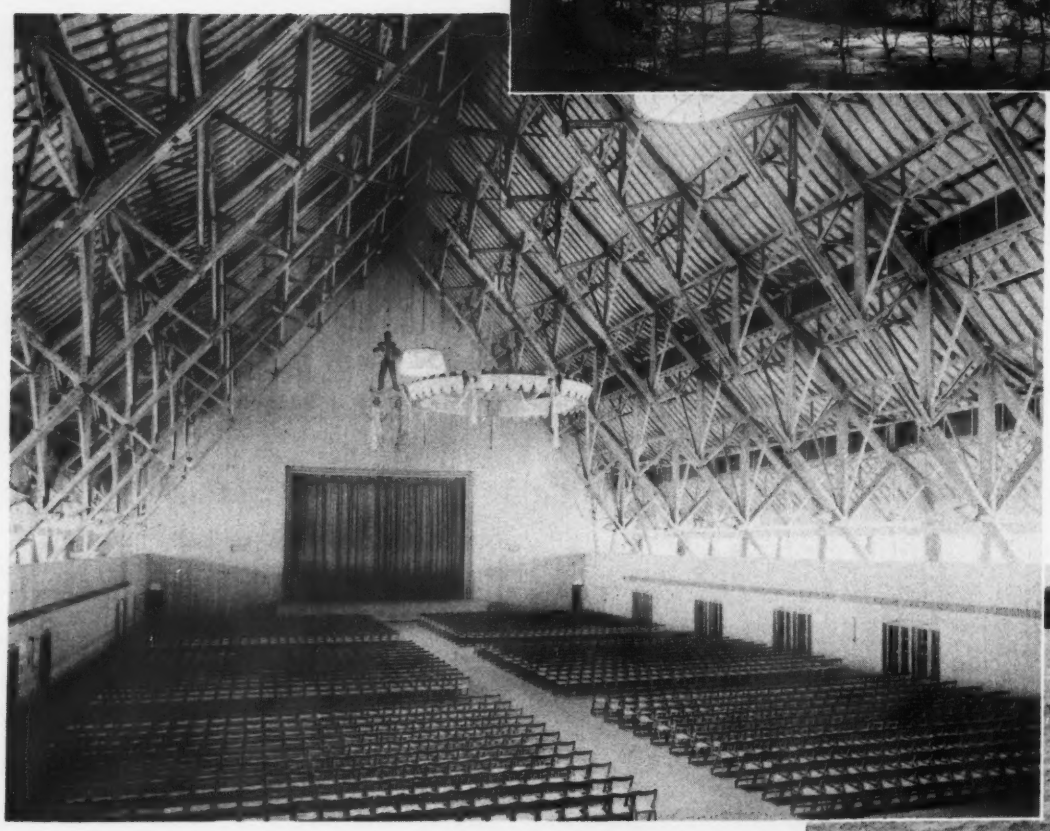
The main assembly line. In spite of such techniques, the output was low. Notice that it is the army model that is being constructed

One of the spacious machine shops, with a chemical laboratory in the background



The main dining hall, ready to serve. Murals on the walls and a decorated ceiling add to the atmosphere

A section of the women's dormitories at the factory. No housing shortage here; there is "living room" galore

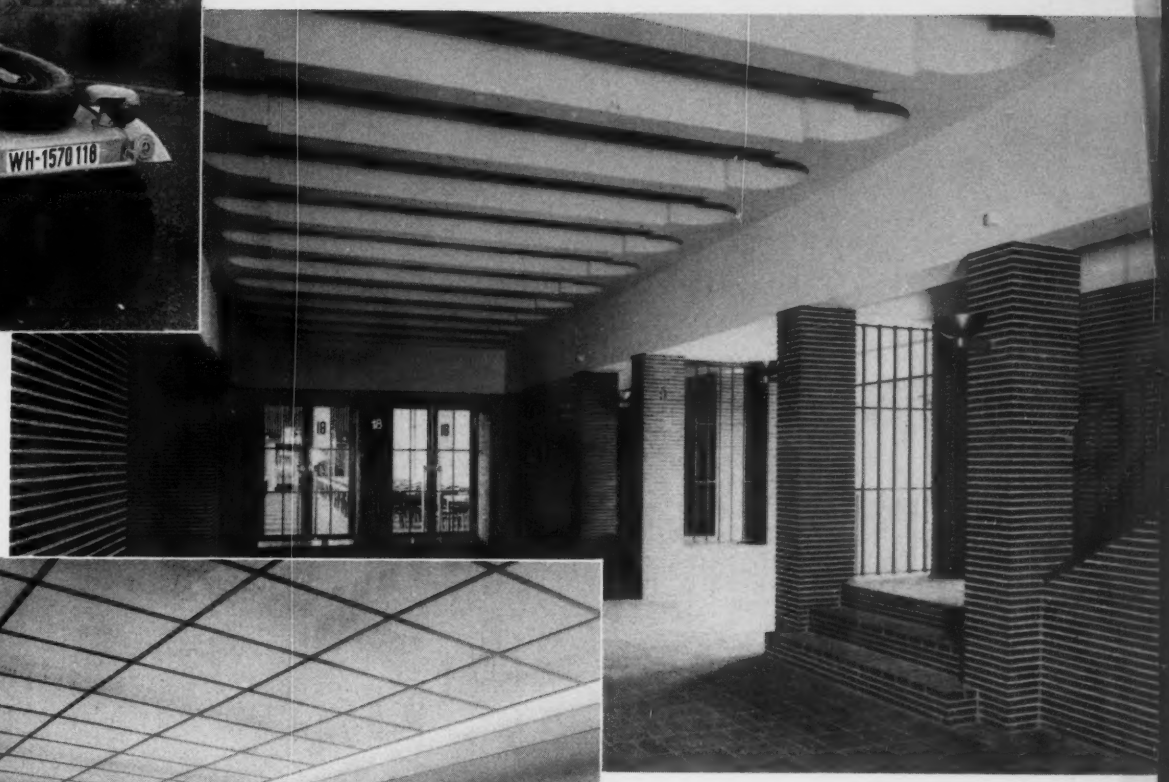


The plant auditorium or "Strength through Joy" Hall

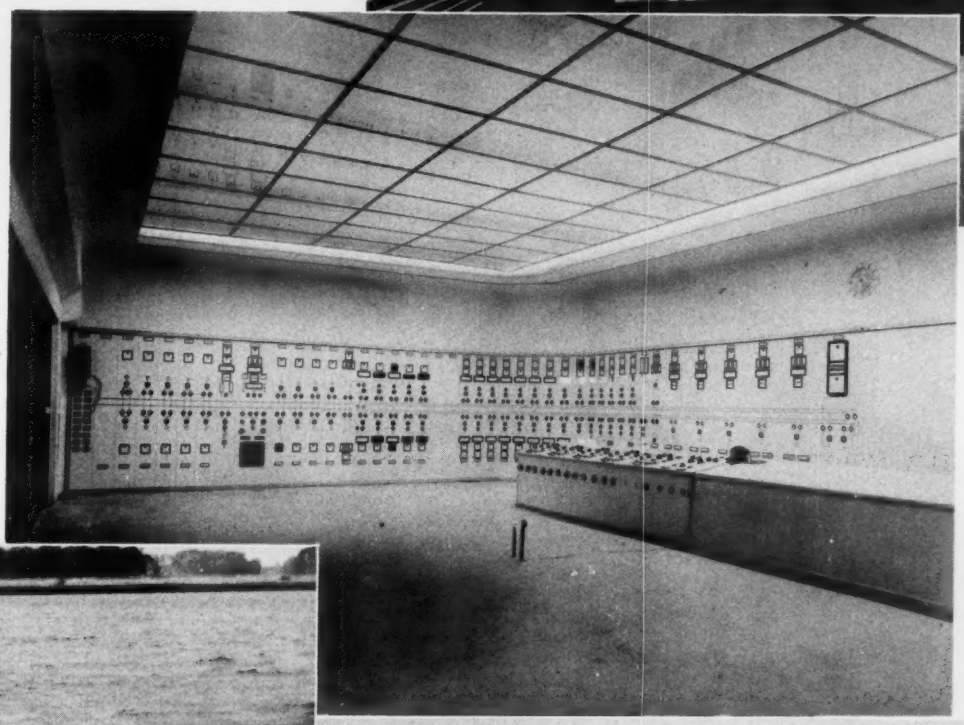
An amphibious model of the Volkswagen leaving the water

The central kitchen, showing the giant cauldrons in the foreground

The army version of the Volkswagen that actually did come off the assembly lines

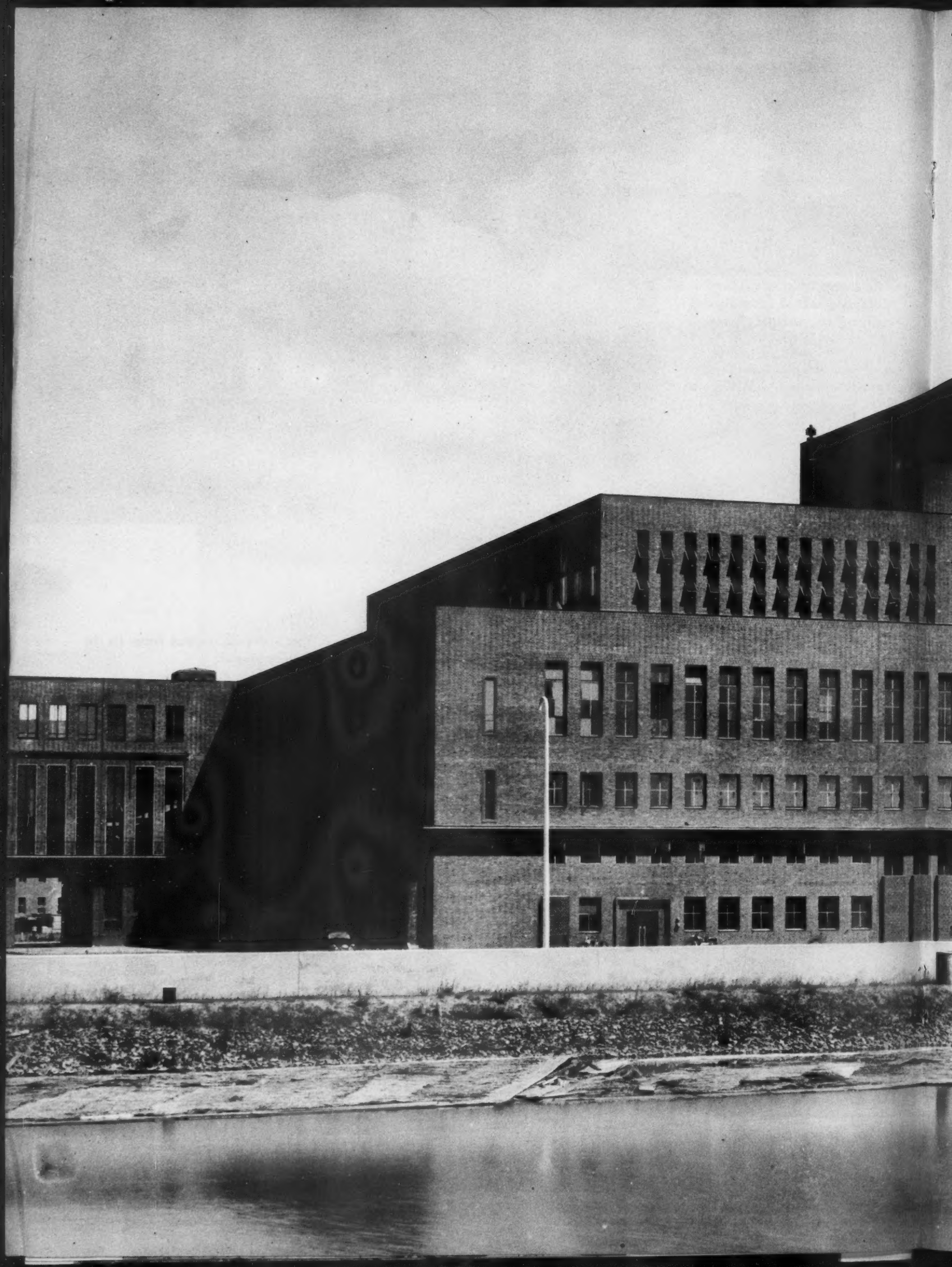


One of the simple but modern entrances to the main dining hall



The spacious control room in the power plant

The army model climbs an embankment



Power plant for the Volkswagen factory

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Can You Do It?

THIS MONTH: A COUPLE OF PROBLEMS THAT LOOK DECEPTIVELY EASY . .

Number 1: A man leaving a department store walks down a descending escalator, touching fifty steps on the way. Later on he again goes down the escalator, this time walking at a rate exactly three times that of his former descent. If he touches seventy-five steps on the way down this time, assuming the escalator to be moving with constant velocity, how many steps are there showing on the escalator when at rest?

Number 2: Nine dangerous prisoners must be taken out for airing on six successive days. For security's sake they are chained in sets of three, one man at the head, one man in the middle, and one man at the end of each chain. Number the men from one to three in the first chain, from four to six in the second chain, and from seven through nine in the last chain. This is the arrangement on the first day. As a precaution against conspiracy, it is desired that no two men be chained directly together more than once during the six days. (Prisoners one and three are not considered as being chained directly.) Can you work out the other five arrangements necessary to satisfy this safety measure?

J. W. W.

(*Answers next month!*)

The Dragon's Den

Attention E. C. M. A. Editors and all Students . . .

For many years now, THE TECH ENGINEERING NEWS has been an active member of the Engineering College Magazines Associated, a nation-wide organization of undergraduate publications in the scientific field. Yearly conventions are held for co-ordination purposes, while monthly criticism is made on the make-up and contents of the various member magazines. But beyond all this routine work, the E. C. M. A. has long been looking for a real job to perform, a job that would involve participation by all the member organizations, something that would be of real service to someone and at the same time give the E. C. M. A. a reputation and a standing.

We think that the opportunity for the performance of such a service has finally come. Recently, one of the organizations around the Institute received a letter from a professor of English at a technical school in France requesting that some students be found who would be willing to correspond with undergraduates of his academy. The letter was posted and a list of prospective correspondents grew on the sign-up sheet below.

In these days of the United Nations and a world-wide desire to know more about people of other countries, there certainly should be some sort of connection between undergraduate bodies of similar institutions around the world. Obviously the question of stirring up individual correspondence is beyond the scope of any work to be done by an organization such as the E. C. M. A. But there is another aspect of the question which pertains much more directly.

We have in our files at the moment a letter concerning the journal *Polyteknikeren*, put out by the students at the College of Technology of the University of Copenhagen, Denmark. The letter requests permission to reprint an article from one of our past issues and is written to us by an executive of one of our large corporations who, through a friend of his, got the original request from the staff of the *Polyteknikeren*.

We believe that this request shows a need much more profound than a simple desire to use material. A foreign magazine of a character so essentially similar to our own should really feel free to write directly to us when we can be of service, and, likewise, we should be able to write them when something is needed that they can supply.

Here is the place for E. C. M. A. to do something really worthwhile. Although it is highly unlikely that the organization itself could be expanded to take in foreign publications, it could work as a central agency to foster connections between the subordinate magazines and as many undergraduate technical magazines from foreign schools as it would be possible to contact.

Certainly, there is much to be gotten from such a tie between managing boards of journals around the world, for as the post-war period develops there will be more and more emphasis upon international co-operation in engineering ventures. If prospective engineers in their various universities and academies could have the opportunity to know something about the kind of work being done by men in like fields in other places than their own schools, it would make work that much easier and would promote a feeling of international freedom of inquiry and understanding. There are many internationally circulated professional journals and news digests, but, at present, none on a student level. Would not such a development be logical and useful?

We, here at *T. E. N.*, feel that correspondence of this nature is a worthwhile investment of time and effort, and would be willing to create the position of Corresponding Editor solely to take care of such duties. In that connection we would like to hear from anyone around the Institute who has any interest along this line. But the final action for any large-scale activity must come from the E. C. M. A. as a unit. Let's see if we can get this movement started soon. Attention, you other college editors! What do you say?

J. W. W.

Here is a weapon that beat the Wehrmacht, a cross section view of the submarine "cable" that piped oil from Great Britain to the Allied forces on the European mainland. Paid out from huge coils in the holds of ships, more than 20 flexible pipelines were laid under the English Channel.

As the picture indicates, this "cable" comprises a lead alloy tube, steel reinforcing tapes, steel wire armor and jute wrappings. It's actually a submarine cable except there's no core. Oil flows in the space normally occupied by the electrical conductors.

The Okonite-Callender Cable Company was one of four American wire and cable manufacturers who together turned out 140 nautical miles of this pipeline. Experience in working with others to solve special manufacturing problems is combined at Okonite with years of research and development work in electrical wire and cable improvement. The Okonite Company, Passaic, New Jersey.

OKONITE
4294 insulated wires and cables

COMPOUNDS OF THE RARE GASES

(*Continued from page 60*)

He examined mixtures of helium and the vapors of mercury, iodine, sulfur, and phosphorus under the influence of electron bombardment and in the presence of surfaces cooled by liquid air. Solid substances believed to be helium compounds condensed on the cold surfaces. Helium disappeared at a rate much greater than would be expected in the absence of compound formation. Further experiments were carried out to show that the effect was not due to occlusion or absorption.

The substances have vapor pressures around .005 mm. at −185° C. and they decompose suddenly at definite temperatures on warming. The decomposition temperatures are: HgHe and HeI −70° C. and HeS and HeP −125° C. The original amount of helium is recovered on heating above these temperatures.

In 1932 van Antropoff and co-workers[12] attempted to form halogen compounds of krypton and argon. They circulated krypton vapor at one to five millimeters pressure mixed with chlorine vapor through a tube, through an electric discharge, and over a liquid air trap. When the circuit was closed the pressure dropped to half in ten minutes. The same pressure drop occurred with krypton and bromine but not with krypton alone or argon and chlorine. The explanation seems to be that a compound of krypton was formed.

In van Antropoff's original paper a red solid was mentioned as appearing in the liquid-air trap after the pressure drop had taken place. This was claimed to be the krypton-chlorine compound. But the authors[13] later amended this when the red solid was found to be a compound of NO and HCl. The observed pressure drop still stands, however, as some evidence for compound formation.

Further attempts to get the rare gases to combine with the halogens have not proven successful. Ruff and Menzel[14] used van Antropoff's method on argon and krypton and fluorine. They observed no evidence of compound formation. Van Antropoff[15] said that differences in the experimental conditions and energy magnitudes involved made any conclusions drawn from this later experiment inapplicable. An attempt by Yost and Kaye[16] to prepare xenon compounds with chlorine and fluorine under conditions of low temperature and electric discharge also was unsuccessful.

Helides

The first report of a metal-rare gas compound was made by Manley[17] in 1924. He was experimenting with mercury and various gases and he found that under certain conditions and in the presence of an electric glow discharge, mercury and helium combined to form a stable compound. As the formation of the compound proceeded, a decrease in the pressure of the system was noted. The compound was stable up to red heat, but on further heating the original volume of helium was restored. Quantitative studies showed that two compounds — HgHe and $HgHe^{10}$ were present.

An attempt by Lind and Bardwell[19] to form mercury helide in the presence of alpha particles from radon showed no evidence of compound after twenty-two hours of exposure. Boomer[20] in 1925 subjected helium in contact with a tungsten filament to electron bombardment and found evidence of WHe_2.

Morrison[21] obtained a gaseous helide of radium by passing helium over a strong radioactive source of radium B and radium C and then through a glass wool filter to a zinc sulfide screen where an electrodeless discharge excited the radioactive atoms and these excited particles caused scintillations to appear on the screen. He tested other gases in the apparatus. Hydrogen produced a large number of scintillations, as might be expected, by the formation of a gaseous hydride. Oxygen and nitrogen produced no scintillations, so the effect observed with helium is presumed not to be due to radium alone or to solid particles in suspension. The number of scintillations produced by helium was less than the number from hydrogen, but was too great to be accounted for by impurities in the helium. Thus, a gaseous helide of radium must be presumed to exist.

Platinum-Helium

The platinum-helium system was chosen by Damianovich as the basis for an attempt to establish the chemical activity of the rare gases. He[22] deposited platinum by means of an electric discharge in an atmosphere of spectroscopically pure helium. The deposit contained between fourteen and thirty-four cubic centimeters of helium per gram of platinum. On heating, the deposit was found to decompose in a vacuum at temperatures between 90 and 160°. The volume of helium released varied with the temperature in a manner similar to a heterogeneous system. Ultra-violet photomicrography showed structural differences between the platinum-helium deposit and the platinum remaining after decomposition. The explanation seems to be compound formation.

In another experiment[23] a platinum electrode was used in an atmosphere of pure helium at low pressure. The deposit which formed was more soluble than either pure platinum or similar products formed with platinum and oxygen or nitrogen. A similar trial with

(*Continued on page 80*)

NUMBER 4 OF A SERIES

Newsworthy Notes for Engineers

Cooking handsets with Radio Waves

After V-J Day, the demand for telephone equipment was at an all-time high. Total requirements for telephone handset handles, for example, were 33 per cent above the highest previous production rate. New molding presses would not be available for many months. It was up to Western Electric engineers to find a way to make these important parts *twice as fast* as they had ever been made before. So they called on wartime experience with electronic pre-heating of plastics — cooking with radio waves.

The method formerly used to produce the handles was to mold granular plastic into solid handles with conductor wires imbedded in them.

In the new method, granular plastic is first molded into a "pre-form", about the size and shape of a hockey puck. These forms are then "cooked" or heated to the consistency of butter by subjecting them to high frequency current—then placed in molds for final shaping. The new handles have hollow cores through which the insulated conductors are pulled.

This method doubles the output of handles, increases strength due to more uniform heating, improves finish, reduces amount of material used.

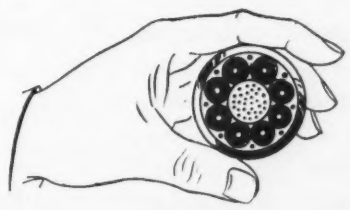
Coaxial Cable by the mile

To meet future needs for long distance telephone and television circuits, the Bell System is constructing a nationwide network of coaxial cable. Ingenious machines designed by Western Electric engineers are now turning out coaxials like spaghetti.

A coaxial unit consists of a copper wire supported centrally in a copper tube by plastic disc insulators. The copper sheath is covered by two layers of steel tape.

One machine punches out the plastic discs. A second machine feeds the discs through chutes onto wheels which force them onto the wire at precise intervals. The wire then travels through mechanisms which notch and form the copper tape around it and finally apply the double wrapping of steel tape.

All these processes are carried on continuously. Copper wire goes in one end of the machine—complete coaxial units come out the other end.



A cable like this, with eight coaxial units, can carry as many as 1440 telephone messages simultaneously—can handle television frequencies up to 2,800,000 cycles per second.

It takes 17,000,000 insulated pieces to make one part

It sounds fantastic — but it's one of the unusual feats accomplished by Western Electric engineers in producing compressed powdered cores for inductance coils used in the Bell Telephone System.

Thin "overcoats" of an insulating material are put on *every particle* of the molybdenum-permalloy powder of which the cores are made. The particles—averaging about 40 microns or 1½ thousandths of an inch in diameter — are coated with a minimum thickness of insulating material by precisely controlled mixing.

The resulting film has to meet three major requirements: It must not break away during compression and heat treatment of the core; it must isolate the particles electrically to reduce eddy current loss; it must remain chemically inert throughout the lifetime of the magnetic core.

Developing quantity manufacturing processes calling for scientifically controlled laboratory precision, is an interesting part of the complex, high quality production job for which Western Electric has long been noted.

Manufacturing telephone and radio apparatus for the Bell System is Western Electric's primary job. It calls for engineers of many kinds — electrical, mechanical, industrial, chemical, metallurgical — who devise and improve machines and processes for large scale production of highest quality communications equipment.

Western Electric

A UNIT OF THE BELL SYSTEM SINCE 1882

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Many manufacturers find it hard to make things fit in a peacetime production scramble. But Nichols knows how to produce precision parts quickly and economically both in war and in peace. Its list of "firsts" during the war included such "impossible" production feats as fuel-injection pump parts for airplane engines, the lubricating-scavenging pumps for jet propulsion engines, and the first machine in the world for milling wind tunnel airfoils. In peace, its "firsts" included the development of the rayon pump, the lapping process on plastics, and development of methods for making the gerotor pump elements.

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—JAMES RUSSELL LOWELL

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FOR DURABILITY

properties of the compound from those of platinum. Among the markedly differing properties observed are: crystal structure, density, appearance, solubility in aqua regia.

4. The presence of helium in the residue left after the compound is attacked by nitric acid shows that the compound is stable.

5. The compound has properties differing from PtO and PtN.

6. There is a maximum amount of helium (37–38 cc. per gram of platinum) which can combine. This corresponds to the formula Pt_3He.

[1] Bradley, *Science Progress*, 31, 282–6 (1936)
[2] Villard, *Compt. rend.*, 123, 377 (1896)
[3] de Forcand, *Compt. rend.*, 176, 355–8 (1923)
[4] *Ibid.*, 181, 15–17 (1925)
[5] Nikitin, *Z. Anorg. allgem. chem.*, 227, 81–93 (1936)
[6] Nikitin, *Nature*, 140, 643 (1937)
[7] Nikitin, *J. Gen. Chem.* (*USSR*), 9, 1167–81 (1939)
[8] Nikitin, *Compt. rend. acad. sci.* (*USSR*), 24, 565–7 (1939)
[9] *Ibid.*, 29, 571–4 (1939)
[10] Booth and Willson, *J. Am. Chem. Soc.*, 57, 2273–80 (1935)
[11] Boomer, *Nature*, 115, 17 (1925)
[12] van Antropoff, Weil and Frauenhof, *Naturwissenchaften*, 20, 688–9 (1932)
[13] van Antropoff, Frauenhof, and Kruger, *Naturwissenschaften*, 21, 315 (1933)
[14] Ruff and Menzel, *Z. Anorg. allgem. chem.*, 213, 206 (1933)
[15] van Antropoff, *Z. Anorg. allgem. chem.*, 213, 208 (1933)
[16] Yost and Kaye, *J. Am. Chem. Soc.*, 55, 3890–2 (1933)
[17] Manley, *Nature*, 114, 861 (1924)
[18] Manley, *Nature*, 117, 587 (1926)
[19] Lind and Bardwell, *Science*, 61, 344–5 (1925)
[20] Boomer, *Nature*, 115, 16 (1925)
[21] Morrison, *Nature*, 120, 224 (1927)
[22] Damianovich, *Anales soc. espan fis quim.*, 26, 365–71 (1928)
[23] Damianovich, *Anales inst. invertigaciones cient. tecnol* 1, 30–63 (1932)
[24] Damianovich and Piazza, *Anales soc. cient. Argentina Seccion Santa Fe*, 7, 57–9 (1936)
[25] Damianovich, *Anales soc. quim. Argentina*, 124, 234–40 (1936)

COMPOUNDS OF THE RARE GASES

(*Continued from page 76*)

hydrogen as the gas produced no deposit or any other evidence of compound. For one of the experiments[24] the following numerical data are given: Helium at pressures of 1.18–1.8 and .28–.5 mm. of mercury was subjected to a current of 10–15 milliamperes with a potential of 600–1,000 volts in the presence of platinum at 24–27°. 20.47–21.65 milliliters of helium combined to form one gram of product. The product on heating showed two different decomposition temperatures: 90–100° and 300–320°. This indicates at least two different compounds.

Mercury was treated for thirty minutes to three hours with the platinum-helium deposit. The amalgam contained all the helium formerly associated with the platinum alone. Attack by 50 per cent HNO_3 left a residue of platinum, mercury, and again all of the helium. The amalgam has two points of maximum helium evolution: 80–100° and 200°. These maxima are independent of the original amount of helium used.

Damianovich[23] supports the claim to a platinum-helium compound with the following facts:

1. The existence of fixed decomposition temperatures different from those of similar compounds.

PtHe	*PtO*	*PtN*	*PtXe*	*PdHe*
90–95°	570°	97°	80°	350°
300–320°				

2. X-ray spectra show rings similar to those given by compounds of platinum with oxygen and sulfur.

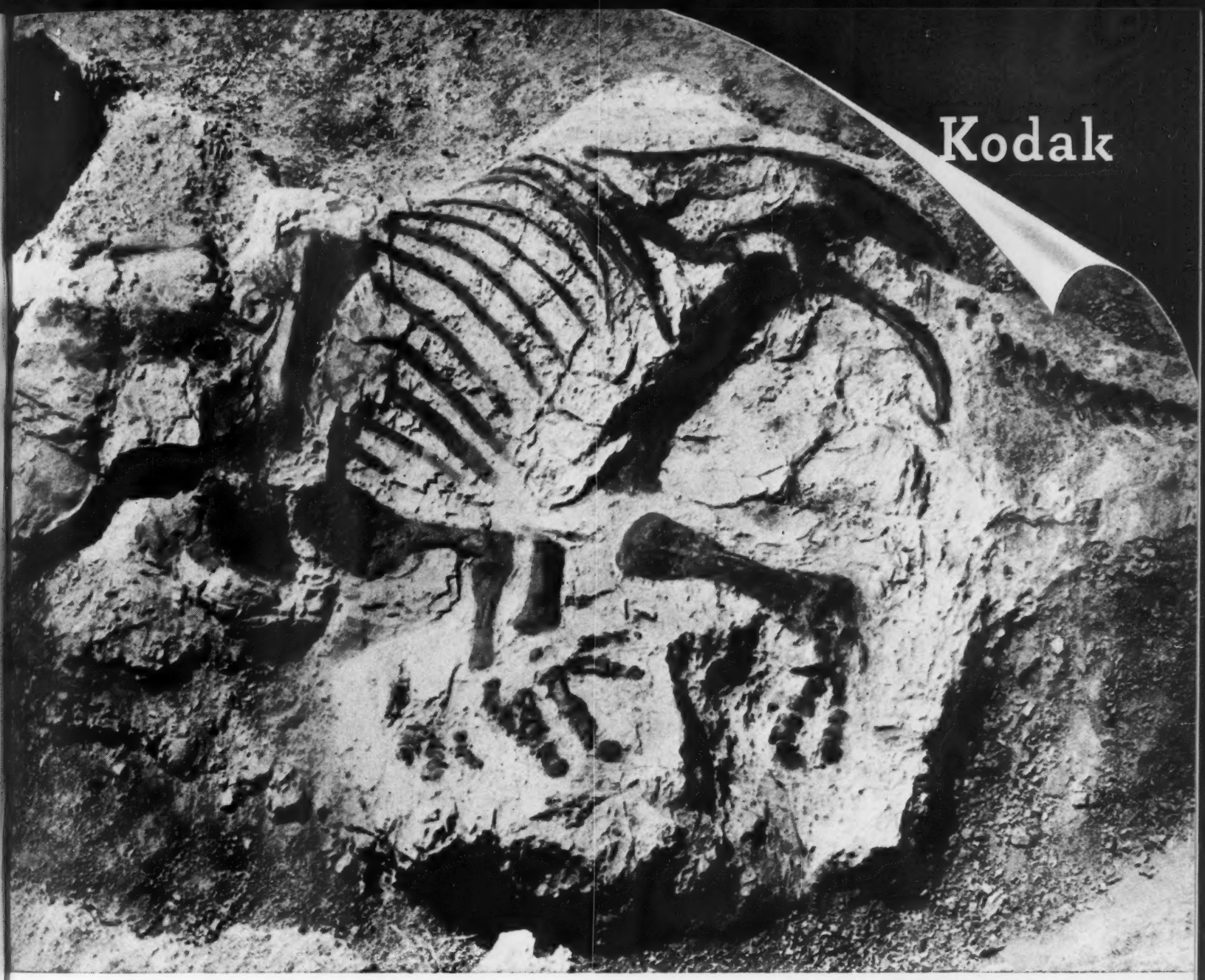
3. There is a fundamental difference in the physical

STARS OR PLANETS?

(*Continued from page 64*)

the presence of another body beyond Uranus. The orbit of this body was calculated and then verified by telescopic research in the computed section of the heavens. A similar series of calculations led to the discovery of Pluto sixteen years ago. Methods similar to these have been applied in detecting unseen components of binary systems. Further calculations can show the relative masses of the primary and its smaller companion (Figure 2). If the companion is a planet, its reflected light will be negligible compared to that of the primary. If, however, the companion is a faint star, made invisible by the glare of the primary, it will still have enough light to affect the image of the primary. The two will blend into a photocentric image nearer the center of mass of the system, thereby shortening the actual orbit of revolution. Since it is upon this orbit that the masses are calculated, the result will give a lower mass than is actually the case. Since this phenomenon does not occur when the companion is planetary, it becomes a method of determining whether the companion is stellar or planetary.

As instruments become more accurate, and results become more co-ordinated, man will begin to know more about the possibility of other planetary systems, and hence more about his own. And if he can find in the sky a panorama of similar planetary systems in different stages of evolution, he will be able to find out more about our own system, where it came from, and where it may be going.



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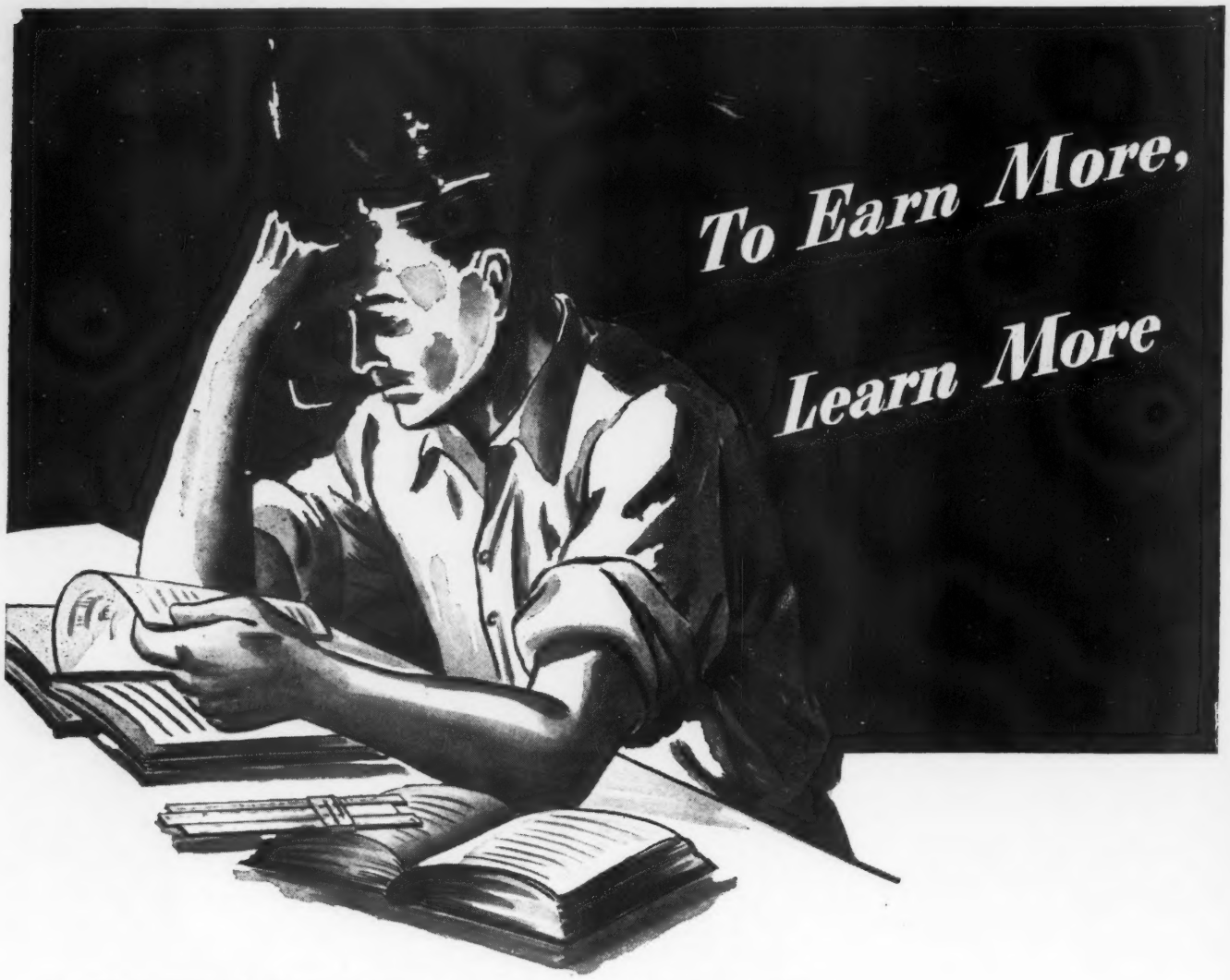

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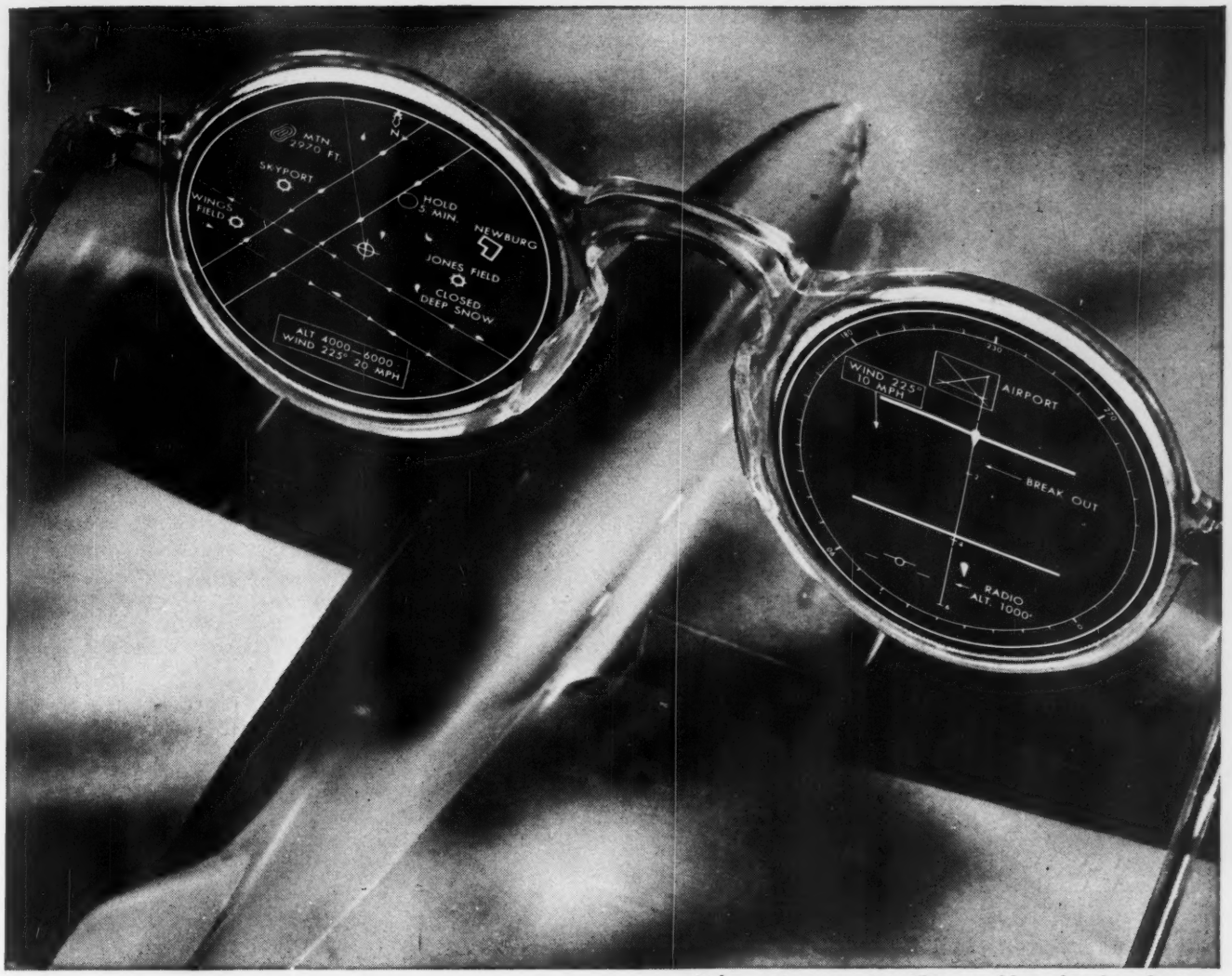
A thorough knowledge of Timken Tapered Roller Bearings will enable you to fully satisfy the bearing requirement in almost every kind of machinery and thus avoid troubles due to inadequate bearing equipment.

Timken Bearings are the first choice of an overwhelming majority of experienced engineers — and have been for many years. They carry all loads—radial, thrust or both together in any combination — with a full measure of efficiency, safety and economy. The Timken Roller Bearing Company, Canton 6, Ohio.



Teleran pictures—air traffic control by radar plus television.

Teleran—"radio eyes" for blind flying!

It's a television "information please" between airplane and airport—with the pilot's questions given split-second answers on a television screen mounted in the cockpit.

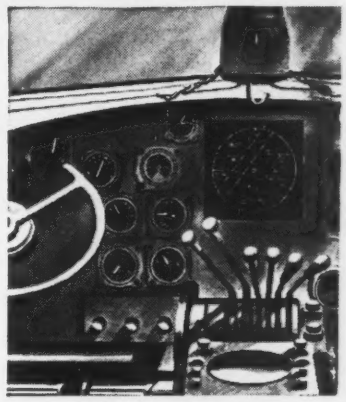
Teleran (a contraction of *TELE*vision—*R*adar *A*ir *N*avigation) collects all of the necessary information on the ground by radar, and then instantly transmits a television picture of the assembled data to the pilot aloft in the airplane.

On his receiver the pilot sees a picture showing the position of his airplane and the position of all other aircraft near his altitude, superimposed upon a terrain map complete with route markings, weather conditions and unmistakable visual instructions. The complex problem of air traffic control is well handled by Teleran.

Teleran—another achievement of RCA—is being developed with Army Air Forces co-operation by RCA Laboratories and RCA Victor, endless sources of history-making developments in radio and electronics. They are also your assurance that *any* product bearing the RCA or RCA Victor monogram, is one of the finest instruments of its kind science has yet achieved.

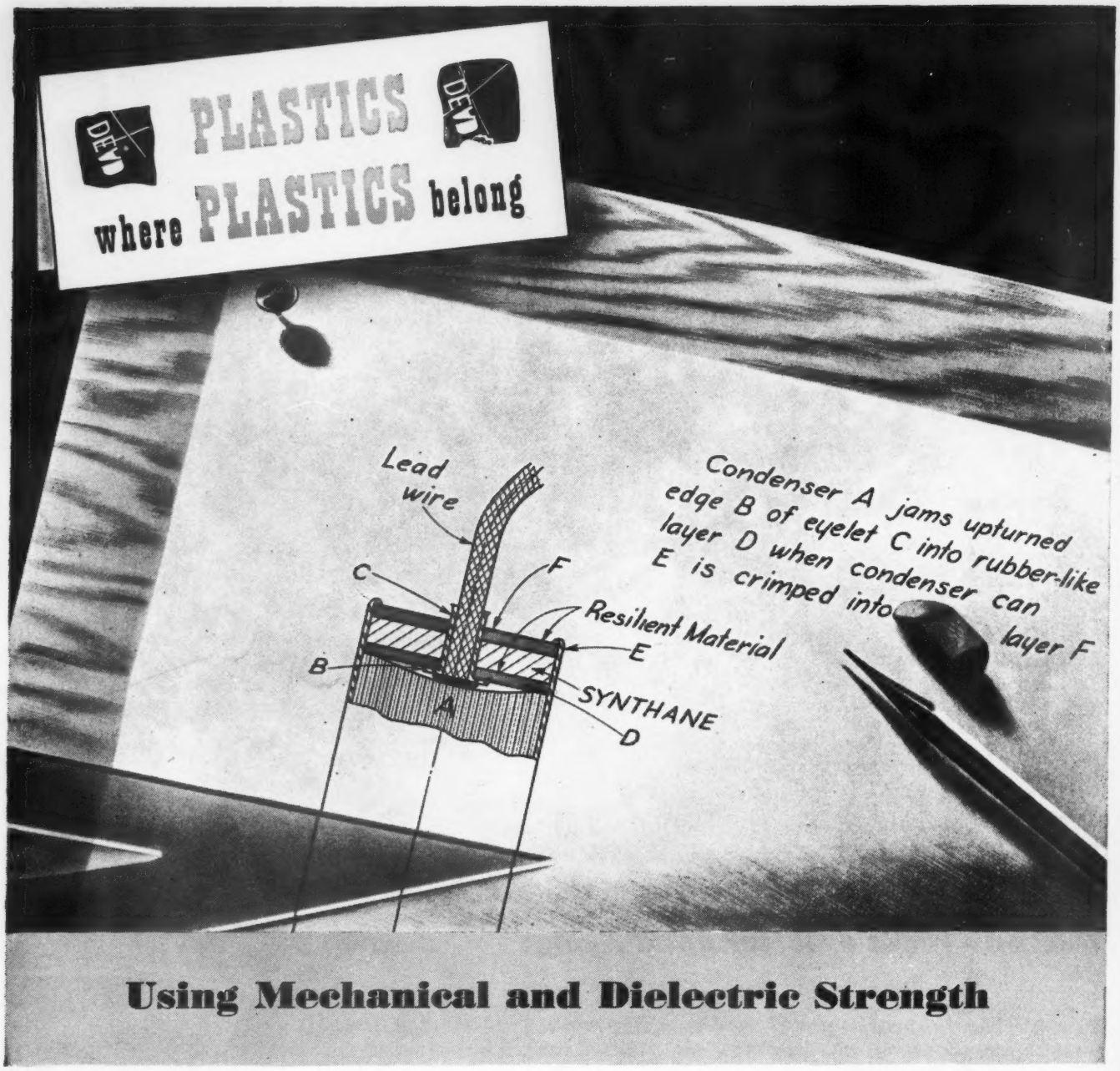
• • •

Radio Corporation of America, RCA Building, Radio City, New York 20 . . . Listen to The RCA Victor Show, Sundays, 2:00 P. M., Eastern Standard Time, over the NBC Network.



Instrument Panel of the Future. The Teleran indicator, mounted in a cockpit, simplifies the pilot's job by showing his position relative to the airport and to other planes in the vicinity. It promises to become one of the most useful developments in the history of aviation.

RCA **RADIO CORPORATION of AMERICA**



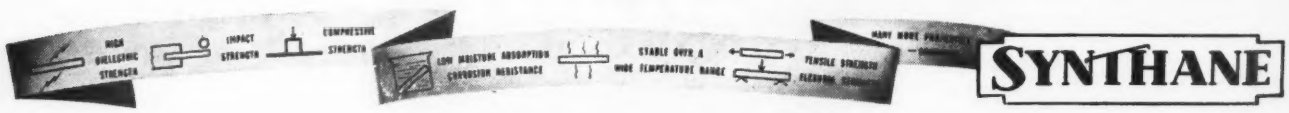
Using Mechanical and Dielectric Strength

SYNTHANE laminated phenolic, sandwiched between and bonded to layers of a resilient material, is the basis of an interesting plastics application.

The assembly—a condenser—depends upon the resilient material for a perfect seal when the edge of the can is crimped. Synthane backs up the resilient material, provides needed strength and rigidity, and is also an excellent electrical insulator, unaffected by condenser oil.

Synthane Fabricated Parts are produced by men who know how to make plastics and how to machine them, using specialized equipment. Synthane Corporation, Oaks, Pennsylvania.

SYNTHANE TECHNICAL PLASTICS DESIGN • MATERIALS • FABRICATION



Du Pont *Digest*

Items of Interest to Students of Chemistry, Engineering, Physics, and Biology

New Plastic Resists Heat, Acids, Electricity

"Teflon," Product of Group Research, is Solving Difficult Problems in Radar, Television and Industry

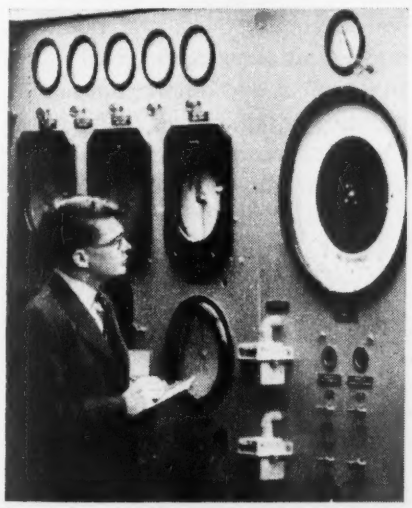
A group of Du Pont research men were looking for a new refrigerant of a particular type. These men found what they were after; but, as so often has been the case, they found something more—this time an industrial plastic whose unique qualities make it invaluable in many fields.

During the study, the chemist in charge proposed a route to the synthesis of HCF_2CF_2Cl via tetrafluoroethylene, $CF_2{=}CF_2$. In working with the latter, a chemically reactive gas boiling at –76.3C./760 mm., it was learned that it polymerized to form a resin having unusual properties.

After evaluation by organic and physical chemists, physicists and electrical experts, a suitable process for the difficult manufacture of this product was worked out by the chemists in collaboration with chemical and mechanical engineers.

Structure and Properties

"Teflon" is made by polymerizing gaseous tetrofluoroethylene to give a solid, granular polymer:



Controlled at this one panel is all the equipment for producing the polymer from which is made "Teflon."

"Teflon" (right) resists boiling acids and solvents to a degree unrivaled by other plastics.

$$n\begin{pmatrix} F & F \\ C & = & C \\ F & & F \end{pmatrix} \rightarrow \ldots \begin{matrix} F & F & F & F \\ C & - & C & - & C \\ F & & F & & F \end{matrix} \ldots$$

The fluorine atoms in the molecule impart exceptional properties of resistance to heat and chemicals.

"Teflon" has unusual heat resistance. Having no true melting point, "Teflon" decomposes slowly to give the gaseous monomer and a few other gaseous fluorine derivatives at around 400°C. Under certain conditions small amounts of fluorine-containing gases have been observed at temperatures above 230°C. Because of its heat resistance, gaskets and wire insulation for jet engines are now made of this plastic. It is also used in aircraft ignition systems near sparkplugs and in high-temperature heating systems.

The chemical resistance of "Teflon" is such that it withstands the attack of all materials except molten alkali metals. Boiling in acid (aqua regia, hydrofluoric acid or fuming nitric acid) will not change its weight or properties. For this reason it may have wide use in such applications as tubing and piping for chemical plants and acid-distillation equipment.

Because the dielectric loss factor is extremely low, even at frequencies up to 3000 megacycles, it is an excellent insulating material for currents of ultra-high frequency. Its heat-resisting and aging qualities suggest immediate uses as a dielectric in coaxial cables for color television, and in radar and power fields.

Forms of "Teflon" Available

By use of special techniques the new plastic can be extruded as rods, tubes or wire coating. In general, its extrusion rates are low in comparison to other thermoplastics because of its resistance to softening.

More facts about "Teflon" are in Du Pont Plastics Technical Service Bulletin No. 13. Send your request to 2521 Nemours Bldg. Wilmington 98, Del. "Teflon" is one of the many products which represent the work and skill of Du Pont men, who, working as a team, contribute toward a better America for you and all of us.

More facts about Du Pont—**Listen to "Cavalcade of America," Mondays, 8 P.M. EST, on NBC**

Questions College Men ask about working with Du Pont

"WILL I STAY IN ONE FIELD AT DU PONT?"

The first position of a new man at Du Pont is based on his expressed preference and an estimate of his aptitudes and abilities. Subsequent work may be in the same or other fields, as openings present themselves in research, production or sales divisions. Keynote of Du Pont personnel policy is promotion from within on a competitive merit basis.

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READ ABOUT the Westinghouse Graduate Study Training Course ... how it fits you for better jobs and advancement in your chosen profession. Westinghouse owns and operates 29 major plants manufacturing electrical, electronic and mechanical equipment, household appliances, plastics, ceramics and many other products. If you are interested in a future of *extraordinary opportunity*, be sure to send for your copy of "Finding Your Place in Industry"!

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Please send my *free* copy of "Finding Your Place in Industry."

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College ..... Course .....

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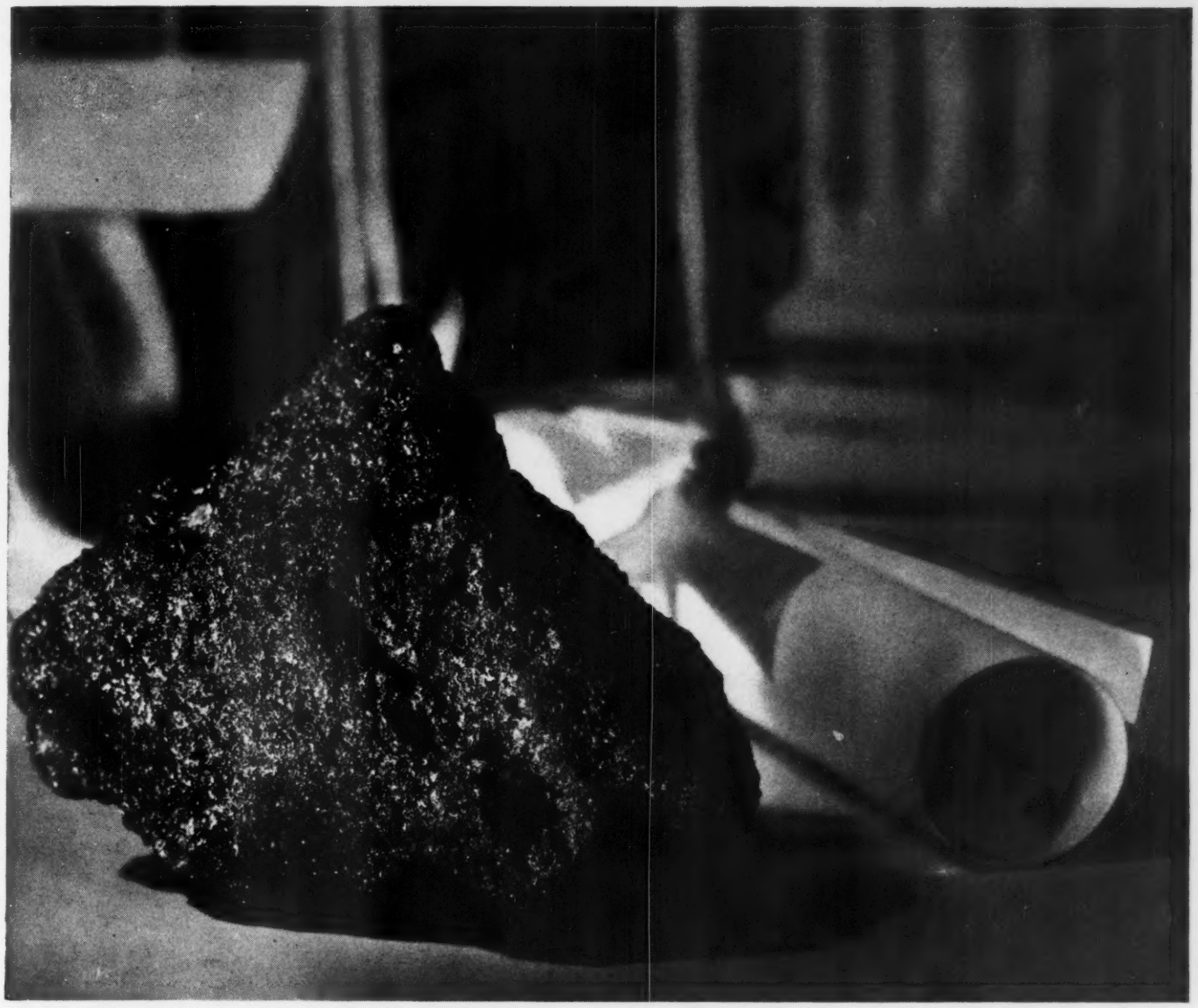


This lump of coal has been to finishing school

AND it has graduated with honors as a piece of *coke*.

It's considerably more refined than it used to be. It's a better and more useful citizen, thanks to its coke-oven education.

Now it burns cleaner than ordinary coal. Burns hotter. Burns longer. And it's ready to provide uniform, economical and efficient heat for your home.

Koppers has done a lot to help supply you with this superior fuel. For Koppers has designed and built most of the coke ovens used in America. And Koppers is itself a big producer of quality coke for domestic heating.

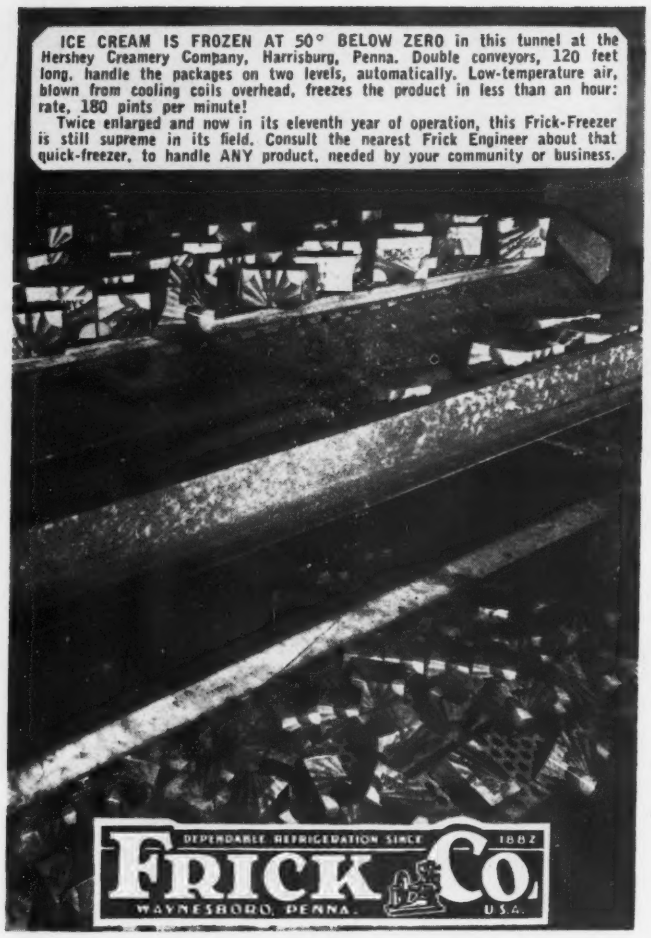
That's just a part of the service Koppers offers to you and to industry. Besides domestic coke, Koppers makes couplings, piston rings, airplane propellers. It manufactures materials for paving, roofing, waterproofing. It pressure-treats timber with preservatives to make it more resistant to weather, decay, moisture and fire. And it engages in many other activities.

It is this versatility, the application of Koppers chemical and engineering skills to so many fields, that has built for Koppers its reputation as "the industry that serves all industry". Koppers Company, Inc., Pittsburgh 19, Pennsylvania.

The industry that serves all industry

KOPPERS

K KOPPERS


ICE CREAM IS FROZEN AT 50° BELOW ZERO in this tunnel at the Hershey Creamery Company, Harrisburg, Penna. Double conveyors, 120 feet long, handle the packages on two levels, automatically. Low-temperature air, blown from cooling coils overhead, freezes the product in less than an hour: rate, 180 pints per minute!
Twice enlarged and now in its eleventh year of operation, this Frick-Freezer is still supreme in its field. Consult the nearest Frick Engineer about that quick-freezer, to handle ANY product, needed by your community or business.
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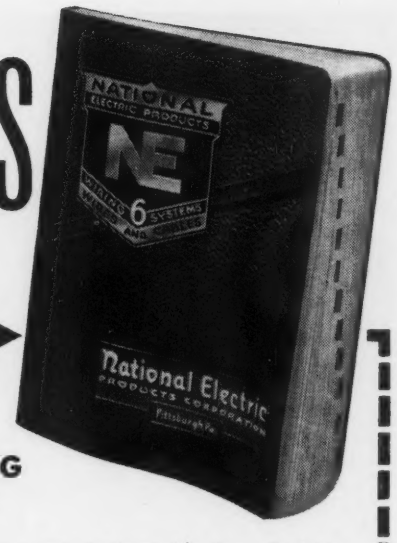

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XB-35 GIANT WING

(*Continued from page 58*)

The flight test instrumentation on the first XB-35 is very comprehensive. Permanent records of all important flight and engine instrument readings are taken by automatic recording devices. An innovation used during the early phases of flight testing, and on the first flight, was the transmission by television of instrument readings from the XB-35 in flight to an accompanying P-61 night fighter.

Northrop's Flying Wing is the closest approach yet made to an airplane consisting only of a pure supporting surface — a plane in which every exposed portion contributes to lift in return for the drag it causes.

On a conventional airplane, only the wing contributes in return for the drag it causes. The fuselage, engine nacelles, tail surfaces, and all other extraneous parts create drag, and contribute only in rare instances and in small degree to lift. On the Flying Wing, virtually all exposed parts of the aircraft are the wing itself, and thus create lift. This increased lift makes possible greater loads. Meanwhile drag is decreased by the elimination of the fuselage, tail surfaces, and exposed engine nacelles. Longer range and greater speed is the result.

Northrop has flown twelve tailless aircraft since the present company was formed in 1939. Northrop engineers have learned much from these experimental models, and have made further studies with wind tunnel tests. Data recorded in these experiments indicate from fifty to one hundred per cent greater efficiency (based on the ratio of maximum lift to minimum drag) for the Flying Wing.

Walter J. Cerny, director of engineering at Northrop, believes the advantages of the Flying Wing can be classified in five ways:

(1) The low-drag, high-lift feature, which means that in practice the Flying Wing can transport any weight faster, farther, and cheaper than can an airplane of conventional design.

(2) The simplicity of construction of the Flying Wing. It presents few structural complications and costs less to build, since it is a single unit, in which a structure extends from tip to tip with no added tail or fuselage to build.

(3) The advantage of a better distribution of weight. Compartments all along the span can carry cargo and distribute the weight more evenly over the wing which supports it. This eliminates the need for excessive "beefing up," such as is necessary in conventional planes where the weight is concentrated in the fuselage, and must be distributed over the wing from this point by heavy structural members.

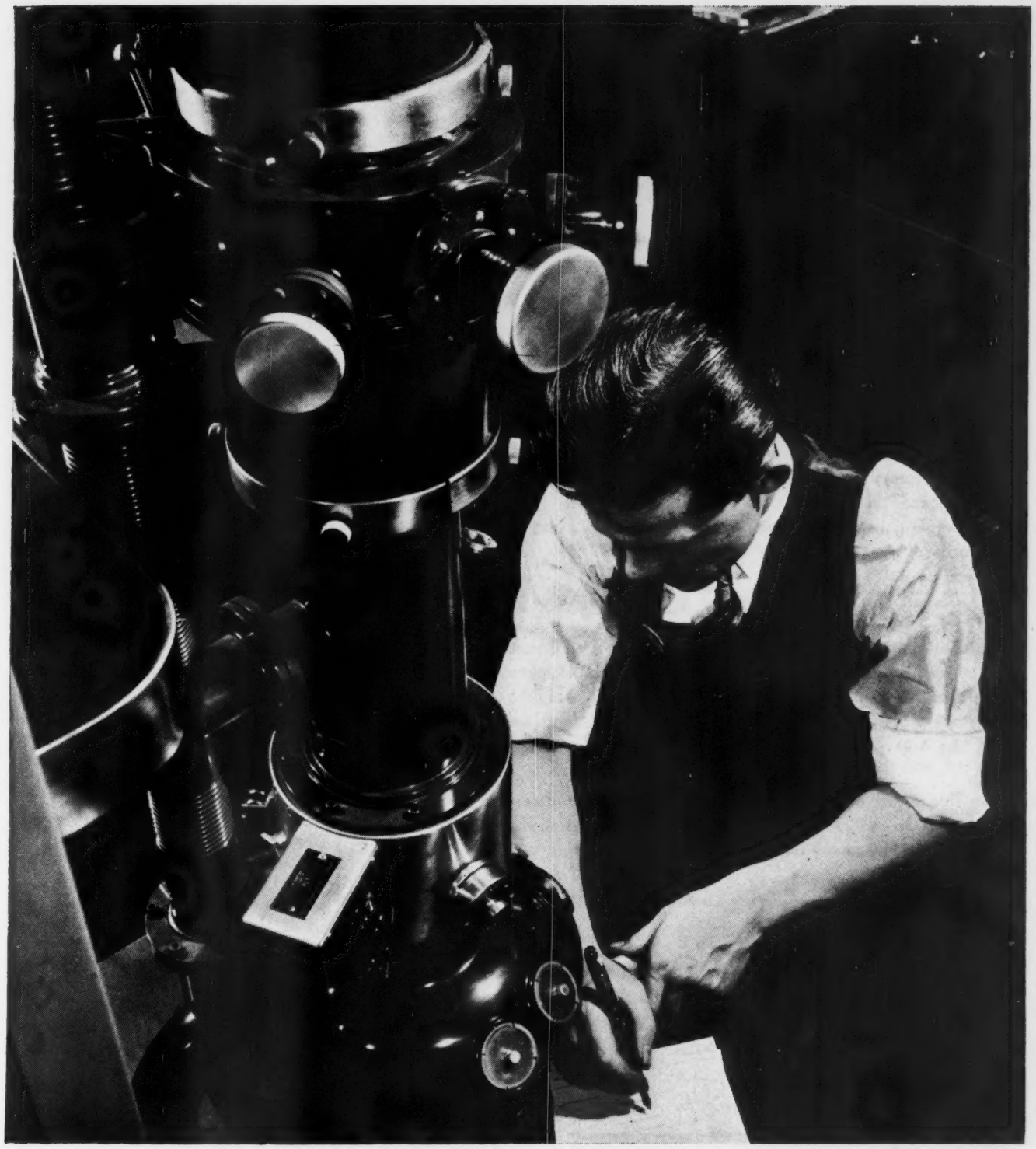
(4) For cargo purposes, the ease of loading and unloading. Cargo can be placed in span-wise compartments, where any part of the plane's load is easily accessible through its own cargo door. This eliminates moving the cargo about for loading and unloading.

(5) For military purposes, the Flying Wing presents a smaller target while engaged either in offensive or defensive maneuvers.

Comparison between the Flying Wing and the conventional aircraft is best illustrated by performance figures obtained from Northrop patent applications and backed up by three years of tests in which planes identical in scale to Northrop's XB-35 were used.

If two airplanes, one a Flying Wing and the other conventional, are built for the same purpose with identi-

(*Continued on page 90*)



Research is Progress . . . and Progress means improved Product quality!

This petroleum company—one of the world's largest—fully recognizes the importance of research. They deem it their responsibility to help maintain American leadership in the field of petroleum research and in the production of fine fuels, lubricants and chemical products derived from petroleum.

Over 2000 scientists and technicians are engaged in Esso research work... and their ranks are being swelled still further!

Esso Laboratories are the largest petroleum research laboratories in the United States—and work to enlarge them has already started.

Unending, intensive research of this nature always assures high quality and dependability in Esso Products... at sea, in the air and on the ground.

Esso

Unending Research Work Assures The High Quality Of All Esso Products

PROBLEM—You're designing a taxi-cab meter. You have worked out the mechanism that clocks waiting time and mileage and totals the charges. Your problem now is to provide a drive for the meter from some operating part of the cab—bearing in mind that the meter must be located where the driver can read it and work the flag. How would you do it?

THE SIMPLE ANSWER

Use an S.S.White power drive flexible shaft. Connect one end to a take-off on the transmission and the other to the meter. It's as simple as that—a single mechanical element that is easy to install and will operate dependably regardless of vibration and tough usage. That's the way a leading taximeter manufacturer does it as shown below.

★ ★ ★

This is just one of hundreds of power drive and remote control problems to which S.S.White flexible shafts are the simple answer. That's why every engineer should be familiar with the range and scope of these "Metal Muscles" for mechanical bodies.

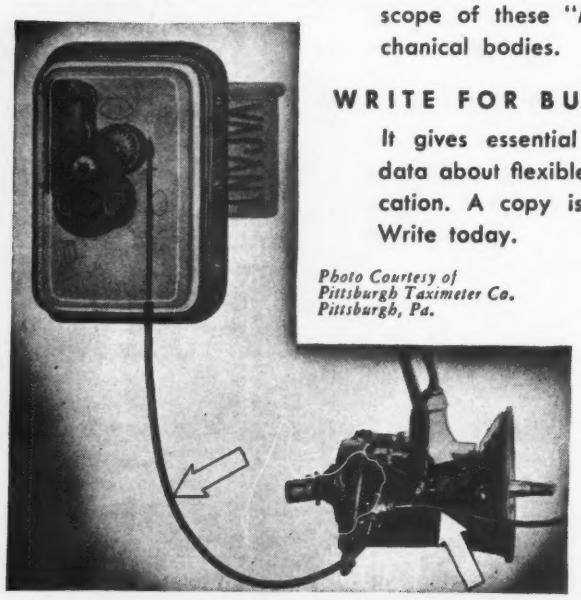


Photo Courtesy of Pittsburgh Taximeter Co. Pittsburgh, Pa.

WRITE FOR BULLETIN 4501

It gives essential facts and engineering data about flexible shafts and their application. A copy is yours for the asking. Write today.

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XB-35 GIANT WING

(Continued from page 88)

cal power, gross weight and fuel load, the Flying Wing will:

(1) Carry one-fourth more useful load in the form of passengers, cargo, or fuel.

(2) Travel one-fourth farther with an identical fuel load.

(3) Transport twenty-five per cent more load over a given distance on a given amount of fuel.

(4) Travel substantially faster with the same "thrust" or applied horsepower.

Engineers believe the XB-35 to be at least twenty per cent faster than a conventional craft of the same load and horsepower, but the greatest advantages gained are in range, load, and economy.

One of the simplest methods of judging relative merits of aircraft designs is by the comparison of maximum lift, which is to be desired, to drag, which must be kept at the minimum possible.

This ratio for the best commercial transports or bombers is in the region of 90 to 100 to one. This means that if a conventional plane has a maximum lifting capacity of 100,000 pounds, it will have a minimum drag of at least 1000 pounds, which must be overcome by the engines.

On the Flying Wing, the ratio is estimated between 140 and 200. Thus a Flying Wing with a drag of 1000 pounds would have a lifting capacity of 140,000 to 200,000 pounds, as compared to the 100,000 pounds of the conventional plane.

If the XB-35's are as successful as expected, they will be so superior to existing equipment that the Flying Wing may force radical changes in military aircraft designs. This in turn would hasten the development of commercial airliners built on the Flying Wing principle.

Next Month—

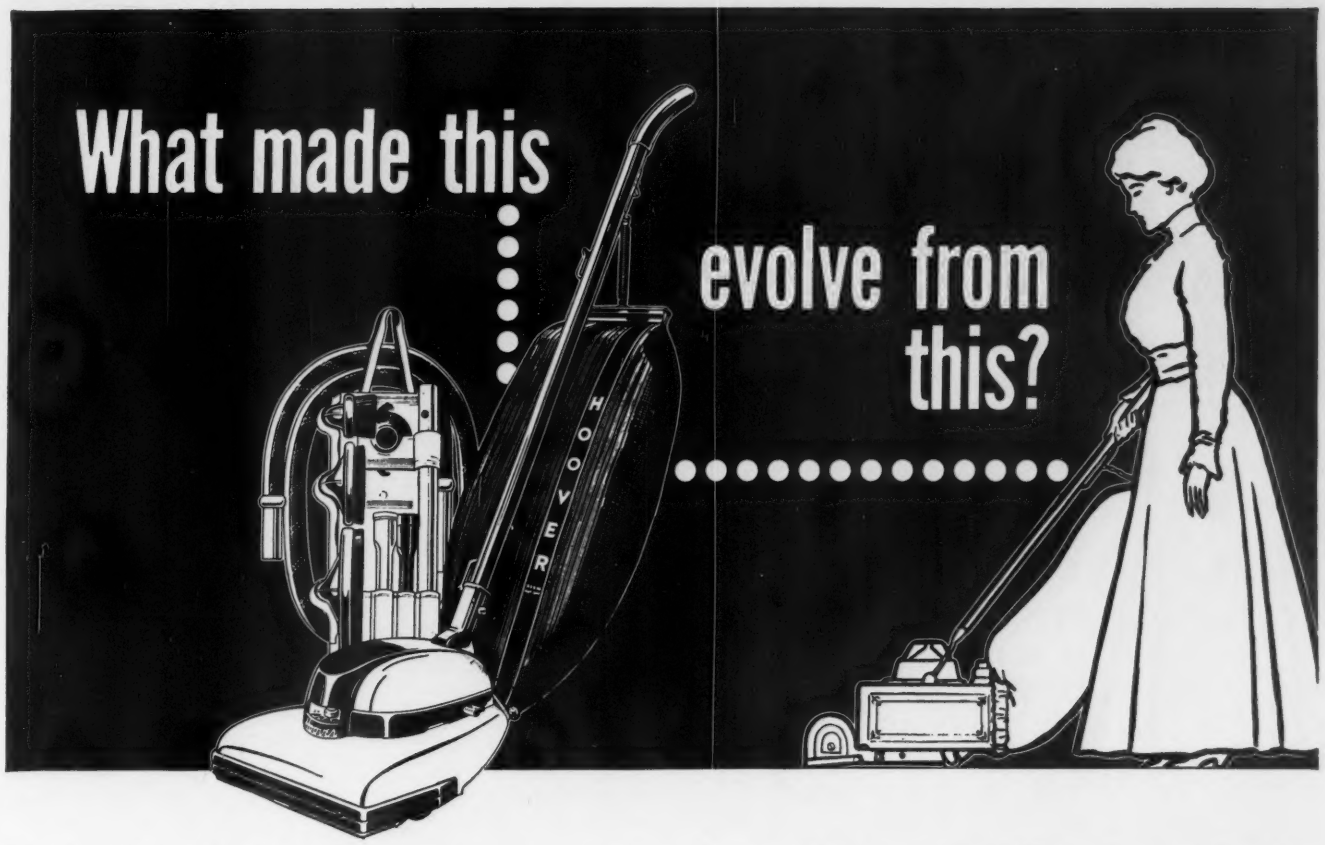
in

T. E. N.

"BIKINI ALLOWS THIRTY SECONDS"

By Joseph Rault

Don't Miss It!



Engineering intelligence, imagination and skill of a high order have been applied continuously, over the forty years of The Hoover Company's existence, to make it possible for women to do a better and easier job of cleaning their homes.

Developing better home cleaners has led Hoover engineers into many fields. This is clearly indicated by the fact that 274 of the 879 patented Hoover engineering developments have been sought and used by other manufacturing industries—many of them far removed from the home appliance field.

Today an engineering staff of 130, one third of them graduate engineers, is required to meet calls made on Hoover engineering skill.

This modern four-story brick building, with a total of 60,000 square feet of floor space and containing up-to-date laboratory equipment, is the Hoover Engineering Department.

The Hoover Cleaner is "born" in the development engineering division, where teamworking skilled designers, inventors and engineers plan tomorrow's electric cleaners.

The laboratory division conducts research, studies and tests, rejects or recommends each component part of each new product "to be."

Mechanical engineers measure noise and vibration, design fan systems, study cleaning methods and solve power transmission problems in developing new designs.

Electrical engineers develop and test motors, wiring, switches, lamps, etc., designing the right power plant and accessories for a Hoover.

Product engineers solve manufacturing problems, set up standards, see that Hoover quality is maintained.

THE HOOVER COMPANY • *North Canton, Ohio*

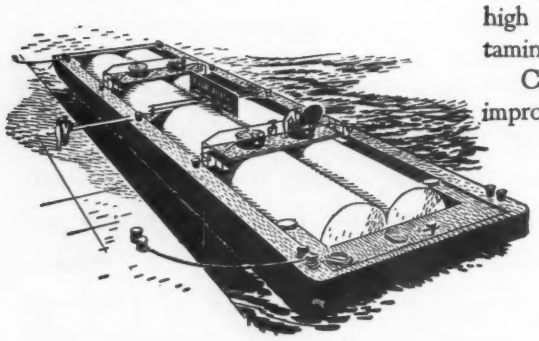
Industry Relies on COLUMBIA for Essential Chemicals

SODA ASH	CAUSTIC ASH
CAUSTIC SODA	PHOSFLAKE (*bottle washer*)
LIQUID CHLORINE	SODA BRIQUETTES (*iron desulphurizer*)
CALCIUM CHLORIDE	CALCENE T (*precipitated calcium carbonate*)
SODIUM BICARBONATE	SILENE EF (*hydrated calcium silicate*)
MODIFIED SODAS	PITTCHLOR (*calcium hypochlorite*)

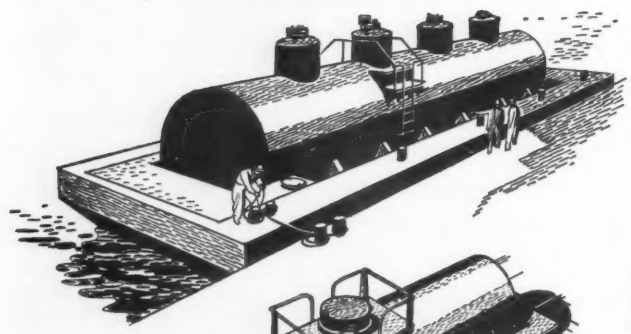
YOU CAN'T SHIP CHEMICALS IN "JUST ANYTHING"

Whether it is a laboratory sample or a 500-ton shipment, methods of handling, and materials used for containers are highly important in maintaining the original high purity of Columbia Chemicals; otherwise they may easily become contaminated in shipment.

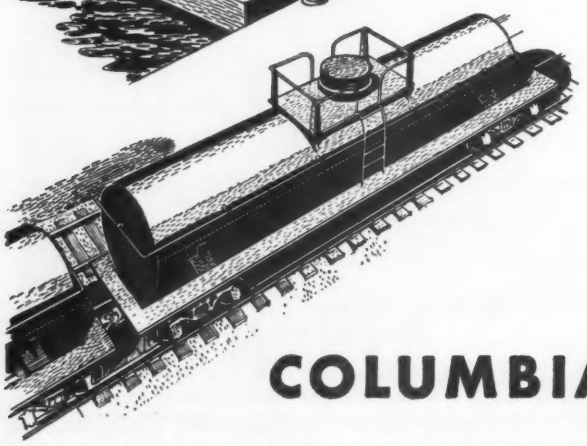
Columbia has pioneered in better transportation methods—has made basic improvements in both rail and water shipment of chemicals.



The First Chlorine Barge:—Before Columbia developed this barge, inland waterway shipments of Chlorine were limited to 1-ton containers. The barge, 135 feet long, has a capacity of *380 tons!*



The First Caustic Soda Barge:—Likewise a big economizer in transportation costs, this 135-foot barge was the first to be designed for Caustic Soda—it makes possible water shipments of 73% *Liquid* Caustic Soda in its purest form.



Chlorine and Caustic Soda Tank Cars:—Forerunners of the barges were Columbia fusion-welded tank cars. They make possible rail shipments of 55 tons of Chlorine per car, and as much as 10,000 gallons of 73% *Liquid* Caustic Soda—the latter being possible by special insulation and inside lining.

COLUMBIA CHEMICALS

PITTSBURGH PLATE GLASS COMPANY • COLUMBIA CHEMICAL DIVISION

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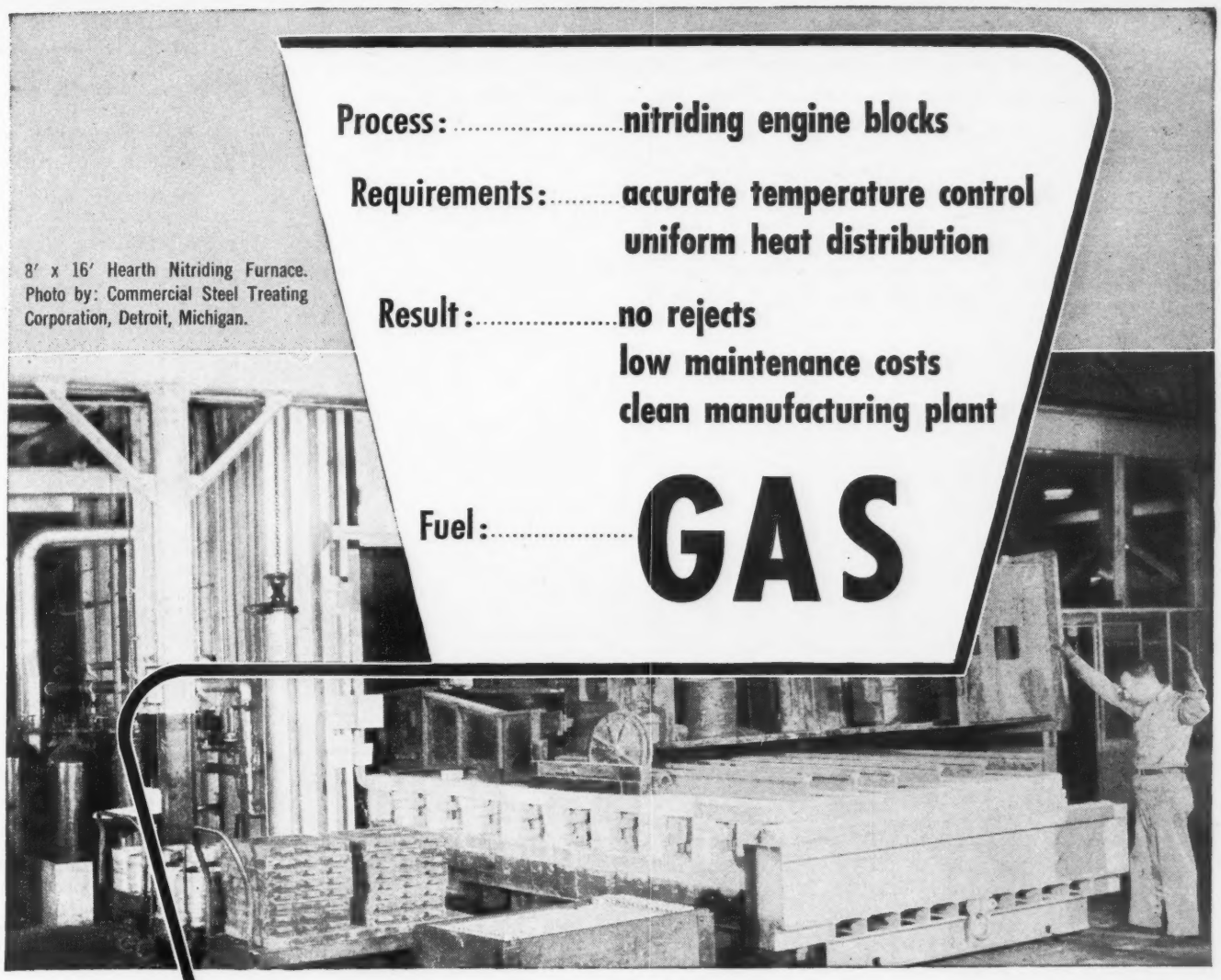

8′ x 16′ Hearth Nitriding Furnace. Photo by: Commercial Steel Treating Corporation, Detroit, Michigan.

Process: ..... **nitriding engine blocks**

Requirements: ..... **accurate temperature control**
uniform heat distribution

Result: ..... **no rejects**
low maintenance costs
clean manufacturing plant

Fuel: ..... **GAS**

Capacity and product specifications for the GAS-fired furnace include:

- **Temperature.....975 degrees F.**
- **Allowable Variation.....+5 degrees F.**
- **Process Time.....96 hours**
- **Case Depth.....0.025 inches**
- **Atmosphere Supply.....Ammonia**
- **Production Rate.....200 Tons per Month**

Commercial Steel Treating Corporation demands accurate temperature control and uniform heat throughout the chamber of its heavy-duty nitriding furnace. GAS fulfills these requirements; five years of successful operation supply the proof.

GAS, dependable fuel for industrial processing operations, meets the most exacting control and heating requirements. Low maintenance costs and cleanliness characterize GAS-fired installations.

Vast new fields for physical and chemical research have been opened by demands in the metal working industry for more extensive use of controlled atmospheres for changing internal and surface characteristics of metals. GAS has become firmly established as the ideal fuel for controlled atmosphere processing.

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FOR ALL INDUSTRIAL HEATING

CORNELL UNIVERSITY
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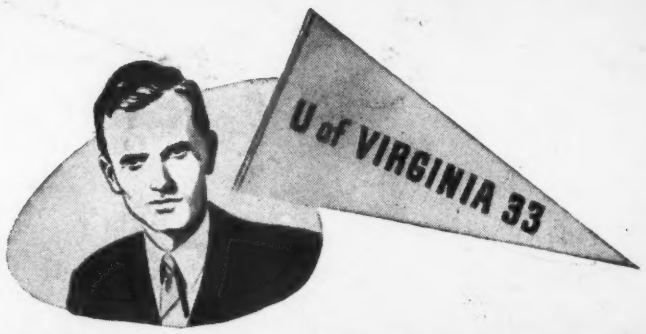
Campus to GENERAL ELECTRIC

ATOM SPECIALIST

The Story of

HERB POLLOCK



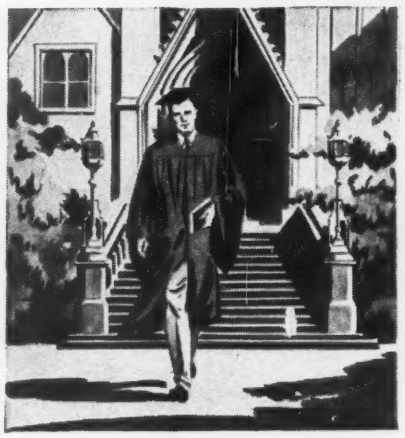
IN 1937, after receiving his doctor's degree as a Rhodes Scholar at Oxford, Herbert C. Pollock came to work in the General Electric Research Laboratory. He knew that at G.E. he would find facilities, opportunity and encouragement to continue his fundamental research into the secrets of the atom.

This was important to Herb. As a senior at the U. of Virginia in 1933, he had studied methods of concentrating isotopes. His doctor's thesis at Oxford was on isotope separation.

When war approached in 1939, isotopes—specifically the uranium isotope 235—became the subject of feverish study, as men sought to exploit the atom's enormous energies. Herb put aside his research into pure science. Working with another G-E scientist, Dr. K. H. Kingdon, he succeeded in preparing a sample of U-235 which was used to confirm the fact that it was this isotope which fissioned under slow neutron bombardment. Later he joined Dr. E. O. Lawrence's Manhattan Project group which was at work on the atomic bomb.

With the Research Laboratory again today, Herb has resumed the fundamental research he began at Virginia and Oxford. Using such complex electronic "tools" as the G-E betatron, he studies the atom that man may have, not bombs, but new sources of power, new weapons against disease, new truths about the physical world.

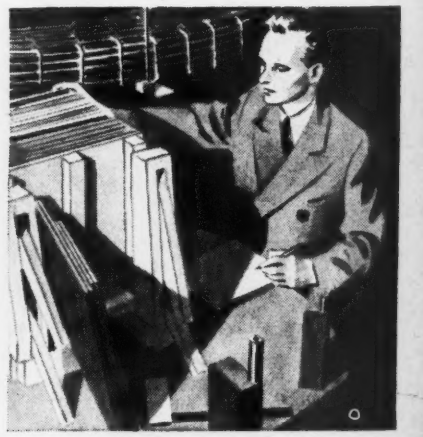
Next to schools and the U.S. Government, General Electric is the largest employer of college engineering graduates.



A Rhodes Scholar, Herb went from the U. of Virginia to Oxford, where he specialized in the study of isotope separation.

Using a specially built mass spectrometer in the G-E Research Laboratory, he isolated an early sample of U-235.

Herb's war assignment: methods for separating uranium for the Manhattan Project, from which came the atomic bomb. Earlier, he helped develop anti-submarine equipment.



Today, back in the Research Laboratory, he uses such "atom smashers" as the 100-million-volt betatron, which is throwing new light on nuclear physics.

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